MACHINERY.

June, 1906.

THE LIGHT MACHINE SHOP.

ITS PROPORTIONS AND EQUIPMENT.

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THE arrangement and proportioning of a manufacturing plant, and its equipment with necessary machinery, in such manner as to insure best working conditions with minimum floor space, is a subject demanding the closest attention of the prospective manufacturer. Plants are frequently erected which prove a constant detriment to economical production, and a continued source of annoyance both to superintendent and workman, due to improper departmental arrangement or to either too great or insufficient floor space. In connection with these latter subjects the writer has compiled various notes; certain of which, pertaining to the manufacture of light high-grade machinery, are submitted herewith.

The selection of the general location is the primary consideration, upon which various details have direct bearing. Steam motive power to-day compares favorably in cost with that of water, and has the advantage of being a constant force under nearly all conditions available throughout the entire year. If we assume then that the power is to be steam, the plant should be located near a personally-controlled water supply, sufficient, at least, to supply a full quota of condensing water, which should daily average not less than one-third the amount which is to pass through the condensers. That is to say, the water in the storage basin will, in warm weather, become too hot for condensing purposes if passed through the condensers more than three times per day. If the water be in sufficient quantity, and of proper quality for boiler feed, it is, of course, so much to the good.

In general, the plant should be located in a region productive of good mechanics, a neighborhood in which there are other factories, either existing or prospective. A machinist is seldom content to "settle down" in any town unless he believes it possible for him to secure other employment in the same vicinity, without being obliged to move his household should he lose his position which he is then holding. To continue, a low first cost may be obtained by locating near a base of supplies, a low rate of transportation of raw materials, power-house and foundry supplies by locating near the sea, and low freight rates by locating near a town containing several railroad lines. A site containing all the foregoing advantages would, of course, be almost purely ideal, but many are to be found which contain two or more of them. Other than the foregoing the main consideration is the cost of foundations. The common soils, other than ledge, are, in order of desirability, hard gravel (hard pan), confined dry sand, and clay, generally considered as capable of supporting 6,000, 4,000 and 2,000 pounds per square foot. All soils should, of course, be carefully tested before being finally built upon.

In order to predetermine the required area for the plant, the type of buildings must be decided upon. The one-story building with its saw-toothed roof is ideal for laying out departments in their consecutive order, as well as the ease with which these departments may be served by traveling cranes, trolleys, etc., but the high cost of land in the East is generally considered sufficient argument against its general adoption. The four-story building is, in this locality, generally conceded to be the most economical. The proper dimensions for buildings of this type, designed to insure good light as well as an economical layout of machinery, are from 50 to 75 feet wide with stories from 12 to 16 feet high respectively. If the buildings are to run north and south, as is generally considered the most desirable arrangement, 70 feet should, if possible, be allowed in the clear between buildings. If they are to run east and west, 90 feet should be allowed between them, and the buildings may be conveniently arranged like a letter U with the eastern side forming the base of the letter.

In the preliminary preparation of estimates of required floor space within the building lines above noted, the following notes have proven useful to the writer. The same are true for economical laying out of machine tools, which subject will later be further discussed.

Size.	Machine.		Greatest No. of Machines per 1,000 square feet.
12 to 20-inch..	Engine lathes.....	Faced same way..	20
12 to 20-inch..	Engine lathes.....	Back to back.....	24
22 to 24-inch..	Planers.....	Heads and tails..	10
22 to 24-inch..	Planers.....	Faced same way.	9
28 to 30-inch..	Planers.....	Faced same way.	5
14-inch ..	Multi-spindle drills...		40
16 to 20-inch..	Upright drills.....		36
26 to 30-inch..	Upright drills.....		12
	Small milling machines. (Similar to No. 4½ Brainard)..		36
	Milling machines..... (Similar to No. 3 Brainard and No. 1 and No. 2 B. & S.)		20
	Automatic screw machines.....		20
	Hand screw machines.		15
	Plain and universal grinders.....		15
	Polishing machines...		24

The above areas are exclusive of main passageways, and if it is decided to run a 6, 8 or 10-foot passage the entire length of the building, this area must be added, also the following areas for each 100 horsepower of plant, which are the average areas in various factories examined by the writer:

Offices	350 square feet.
Storage of office supplies.....	100 square feet.
Shipping and boxing.....	450 square feet.
Storage of tools.....	650 square feet.
Inspecting	1,000 square feet.
Drafting	400 square feet.
Pattern lumber storage.....	75 square feet.
Bar stock storage.....	700 square feet.
Storage of finished parts.....	3,000 square feet.
Storage of patterns.....	220 square feet.

The areas required for setting up and storage of assembled machines will, of course, vary greatly with each individual instance, and no approximate figure can be given. The same must be determined for each individual case.

A "clearance" department capable of caring for at least one-half day's work should be left vacant on each floor. This space to be in excess of any probable growth in adjacent departments.

Roughly: A manufacturing machinist on light work requires 100 square feet floor area average. For example, he will run two milling machines, two engine lathes, but only one planer. A toolmaker or experimental man requires 200 square feet; a molder on light work, 200 square feet, and one on heavy work, 400 square feet.

From the foregoing a close approximation of the amount of land and size of manufacturing buildings may be obtained, and a preliminary layout started after the manner of planning the manufacturing proposition and erecting the buildings around it.

Laying Out Machine Tools.

In the manufacture of light parts, where a proper clearance department is maintained, the storage space near the machine necessary for work in hand is small, and as an operator frequently runs two and even three machines, the nearer these machines are set together, consistent with ease in getting around them, the better it is for economical production. To

this end the writer has adopted the following rules for setting up machine tools. While, of course, exceptional cases have arisen, in general he has found them satisfactory.

	Center to Center.
10 to 20-inch engine lathes set face to face and offset 2 feet or more	4 feet 6 inches.
10 to 20-inch engine lathes set face to face and not offset	5 feet 6 inches.
10 to 20-inch engine lathes set back to back	3 feet 0 inches.
10 to 20-inch engine lathes set face to back	5 feet 0 inches.

Above 34-inch swing the center distance must be determined by the nature of the work usually in hand, and whether or not the machine is to be served by crane, trolley, etc. Least distance from end of one lathe to stud of adjacent lathe in same line ..... 6 feet 0 inches.
Least width of cross passageways in clear.... 2 feet 6 inches.

17 to 24-inch planers set heads and tails, machines in pair, center to center	6 feet 6 inches.
17 to 24-inch planers set heads and tails, machine of one pair to machine of next	5 feet 0 inches.
17 to 24-inch planers set heads and tails, offset between housings	2 feet 0 inches.
17 to 24-inch planers set faced same way, center to center	6 feet 6 inches.
36 to 50-inch planers set heads and tails, machines in pair, center to center	8 feet 6 inches.
36 to 50-inch planers set heads and tails, machine of one pair to machine of next pair	7 feet 0 inches.
36 to 50-inch planers set heads and tails, offset between housings	2 feet 0 inches.
36 to 50-inch planers set faced same way	8 feet 6 inches.

Sensitive and light upright drills up to 24-inch should be set in parallel rows face to face and back to back. Distance in the clear between rows facing each other, 4 feet 6 inches. The writer's preferred method of setting these tools is to place a row of lighter drills opposite a row of slightly heavier, and to work each in conjunction with multi-spindle drills on the end.

Each drill, having a table, should be set so that it may swing entirely out of the way of the platen, and clear the table of its neighbor when the latter is in its central position. Upright drills 24-inch and upwards, if not served by crane, should be set in parallel rows and all faced the same way, clearances between the rows to be from five to seven feet, depending on the size of the work usually in hand. Large drills served by crane should be set face to face with eight feet in the clear, as before, all drills being set so that tables will clear as noted above.

Milling machines, plain and universal grinders set face to face should be set 5 feet 0 inches center to center of platens. Those machines coming back to back must be offset sidewise 8 inches to allow room to drift out their arbors. Machines

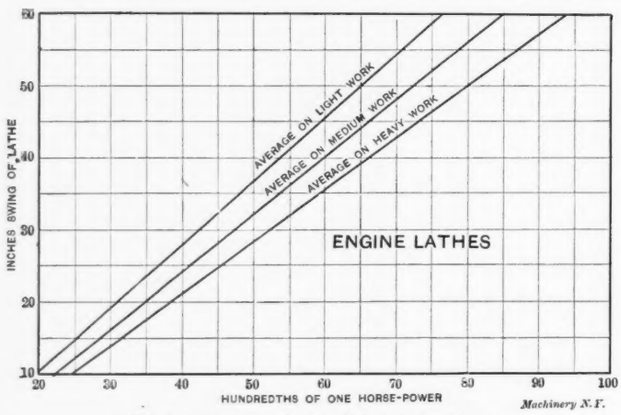

Fig. 1. Power Required to Drive Engine Lathes.

set all facing the same way should have a minimum clearance between rows of 2 feet 6 inches. In general, all machines should be set to leave one foot clearance between adjacent platens when same are in extreme positions.

Automatic screw machines should be set back to back and staggered so that stock for one machine will feed in between the back of machine in same row, and the back of the machine in the row behind it.

Distance between centers, face to face	9 feet 0 inches.
Distance between centers, back to back	4 feet 6 inches.
Angle of Pratt & Whitney machines with line shaft	12 degrees.
Angle of Browne and Sharpe machines with line shaft	12 degrees.
Angle of Cleveland machines with line shaft	16 degrees.

Hand screw machines should be set in rows with cross passageways running diagonally across the buildings, but machines themselves parallel with the line shaft, each machine being set the other way around from the machine next in line longitudinally with it, and with sufficient endwise clearance to allow a 16 or 20-foot length of stock to be inserted.

Polishing machines should be set in rows lengthwise of building, faced same way. Distance between centers of rows, 9 feet 0 inches; sidewise clearance between machines, 3 feet 0 inches.

In the drop forge shop:

Trimming presses should be set as near as possible to the hammer in conjunction with which they are to be used, and to the left of the hammer as you face it. Room only should be allowed to remove the driving pulley. Least practical distance between the trimming press and the hammer in next adjacent pair, 2 feet 0 inches in the clear.

Least practical distance in the clear between the blast forge and the hammer, if forge be water jacketed, 6 feet 6 inches

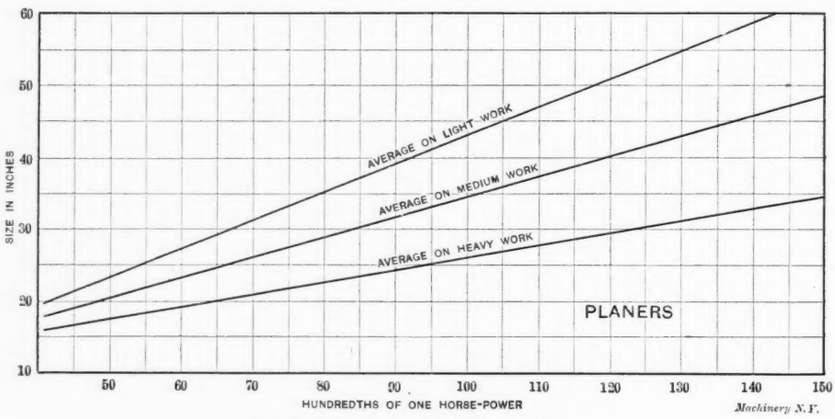

Fig. 2. Power Required to Drive Planers.

in the clear. If forge be without water jacket, 8 feet 6 inches in the clear. Center of blast forge should be offset at least 2 feet to the left of the hammer as you face the hammer, so that the heat will not come directly on the blacksmith's back.

If a helve hammer be set in line with the drops, for breaking down or drawing out, the anvil block should be set 3 feet in front of the base line of the drop hammers. Least distance back of an anvil to safely swing a sledge, 7 feet 6 inches in the clear. Of course, all the foregoing rules will be varied slightly to accommodate belt space, which is the main trouble in economizing floor space.

Before an estimate can be placed on the space required for the power plant, an estimate of the power required by the machine tools, etc., must, of course, be made. In connection with this subject the type of drive (electric group, electric individual, or belt) must first be decided upon. For light machine tools, that is to say, machine tools requiring less than 2 horse power average, the individual drive may at once be eliminated, there being no economy in this type as far as power is concerned, and a large first cost is necessitated. The average efficiency of these light motors at full load is about as follows:

⅛ horse power	28 per cent.
¼ horse power	43 per cent.
½ horse power	56 per cent.
¾ horse power	58 per cent.
1 horse power	70 per cent.
2 horse power	75 per cent.

The efficiency, of course, drops off as the load decreases. In an individual drive the motor must be not only sufficiently large to drive the machine at its maximum load, but also to

overcome the inertia of starting, this, of course, being overcome in group drives by the momentum of shafting and elements of one machine at high power balancing another at a lower power.

The following few comparisons of actual average horse power used and motors actually installed as individual drives for similar machines are made from electrical tests of power of light machine tools, and compiled from notes taken in various shops of motors actually used for individual drives.

Size and Machine.	Average H. P. Required at Machine.	H. P. Motor Required for Individual Drive.	App. Eff Motor at Required H.P.	Average H P. required at Motor.	Average H. P. Lost in Motor.
16-inch engine lathe	.30	2	55%	.54	.24
30 x 30 x 8 planer ...	.87	5	60%	1.45	.58
4-spindle sensitive drill	.47	3	55%	.85	.38
20-inch upright drill	.32	2	55%	.58	.26
No. 2 milling machine	.25	2	50%	.50	.25
2-inch automatic screw machine...	.75	4	65%	1.16	.41
2-inch hand screw machine	.45	3	55%	.82	.37
No. 11 Plain grinder	.75	4	65%	1.16	.41
18-inch shaper	.45	3	55%	.82	.37

Opposed to the above, the per cent friction to total load of line and countershafting for various manufacturing depart-

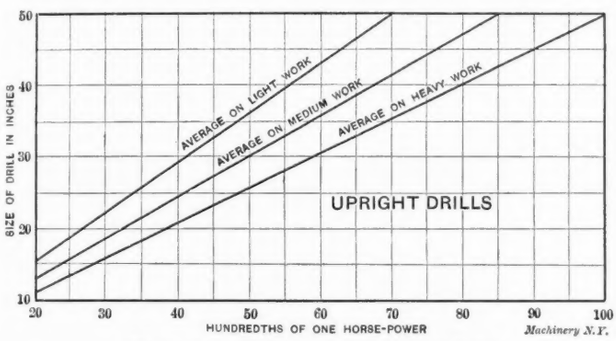

Fig. 3. Power Required to Drive Upright Drills.

ments in which the machine tools are laid out, as before described, is on an average as follows:

Lathe department	30 per cent
Planer department.....	30 per cent
Drill department (belted direct from line shaft)..	20 per cent
Drill department (belted with countershafts).....	30 per cent
Milling department	25 per cent
Screw machine department.....	30 per cent
Grinding department	25 per cent
Cutting-off department	35 per cent

In the average machine shop running at full capacity, generally at least 75 per cent of the total machines are running at the same time, and if driven in groups a machine taking a heavy cut at maximum power will be generally balanced by a machine taking a light cut at minimum power. To quote from MACHINERY'S data sheet of September, 1902: "For group driving, determine average horse power for each tool, add these together, and use a motor with a capacity of from 40 to 70 per cent of the total thus obtained." This is excellent practice if one can be sure that no more machine tools are to be added to the motor load. The writer's method is to assume that 75 per cent of the machine tools installed are to be running at one time, and to provide a motor equal to their combined average horse power. This would mean only a 30 per cent overload on the motor if the entire group were temporarily running at one time.

To demonstrate, let us assume a department of 80 engine lathes averaging 16-inch swing. From above table the average horse power used by each machine alone is .30, or 24 H. P. for the department, if all machines were in operation. Assuming 75 per cent of these machines to be in operation at one time, the two propositions, electric individual and electric group drive, would stand roughly as follows:

Individual drive:

H.P. required to run 60 motors at .54 H.P.....	32.4
H.P. transmitted to 60 lathes at .30 H.P.....	18.0
H.P. lost in motors at .24 H.P.....	14.4

Group drive:

H.P. transmitted to 80 lathes at .30 H.P.....	24.00
Department friction line and countershafts to *total load* 30%	
Total H.P. line shaft, countershafts and 80 lathes....	34.28
H.P. friction line shaft and 80 countershafts.....	10.28
H.P. transmitted to 60 lathes at .30 H.P.....	18.00
H.P. transmitted to 60 lathes, line shaft and 80 countershafts	28.28
Efficiency 30 H.P. motor at full load..... 90%	
H.P. required to run motor	31.42
H.P. lost in motor	3.15
H.P. total lost in motor and shafting.....	13.43

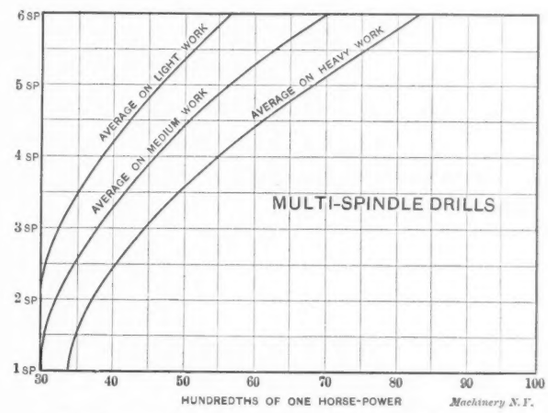

Fig. 4. Power Required to Drive Multiple-spindle Drills.

Summary:

First cost 80 2-H.P. motors at $150.....	$12,000.00
Cost installing 80 motors at $5.....	400.00
Total cost individual drives.....	$12,400.00
First cost 30 H.P. motor.....	$750.00
Cost of installing 30-H.P. motor	12.00
Cost 1,300 feet of belting at 20 cents.....	260.00
Cost 10,000 board feet Southern pine stringers at $45	450.00
Estimated cost shafting, hangers and couplings.	500.00
80 countershafts at $18.....	1,440.00
Estimated cost erecting.....	500.00
Cost of main belt.....	18.00
	$3,930.00
H.P. saved in group over individual drive. 1.00	
Percentage saving in total power..... 3½%	
Saved per year at $30 per H.P..... $30.00	

The accompanying diagrams of required horse power of light machine tools are used by the writer for estimates of power in all places where no accurate electrical tests of power

Fig. 5. Power Required for Board Drop Hammer.

under existing requirements of a particular line of manufacture are to be made. The notes from which these diagrams are made were compiled from electrical tests made in several factories manufacturing light machinery. In conjunction with these diagrams, various machine tools require an average horse power as follows:

Speed lathes	.10 H.P.
10-inch to 18-inch crank planers	.40 to .50 H.P.
Grindstones	.10 H.P.
Cutter and reamer grinders	.30 H.P.
Gardner grinders	.50 H.P.
Polishing machines	.80 to 1.25 H.P.
Radial drills	.75 to 1.25 H.P.
1 to 3-inch cutting-off machines	.15 to .25 H.P.
1 to 3-inch automatic screw machines	.60 to .80 H.P.
1 to 3-inch hand screw machines	.40 to .50 H.P.
20 to 30-inch boring lathes	.35 to .40 H.P.
24-inch wood panel planers	3.75 H.P.
24-inch wood surface planers	2.25 H.P.
14 to 18-inch wood lathes	.30 to .40 H.P.
36-inch gap lathes	1.30 H.P.
Band saws	.90 H.P.
8-inch to 12-inch circular saws	1.00 to 1.25 H.P.
Sand paper wheels	.75 H.P.
17-inch to 20-inch shapers	.40 to .50 H.P.

entrance, all the out-of-door lighting, and incandescent lamps in locker and wash rooms, passageways, etc. One 16-candle power light placed 7 feet from the door will satisfactorily light 250 square feet in a storehouse, and from 100 to 110 square feet general lighting for the factory proper.

The writer has purposely omitted the subject of department arrangement, believing that subject to be superfluous in view of the numerous articles lately written on the direct passage of production through various shops without retrograde movements, all of which articles tell the same story, with minor variations. Powerhouse design and equipment is also a subject too broad to come under the head of this article. The writer's aim has been to supply such notes on areas and power as might be of interest in predetermining the same up to the powerhouse doors.

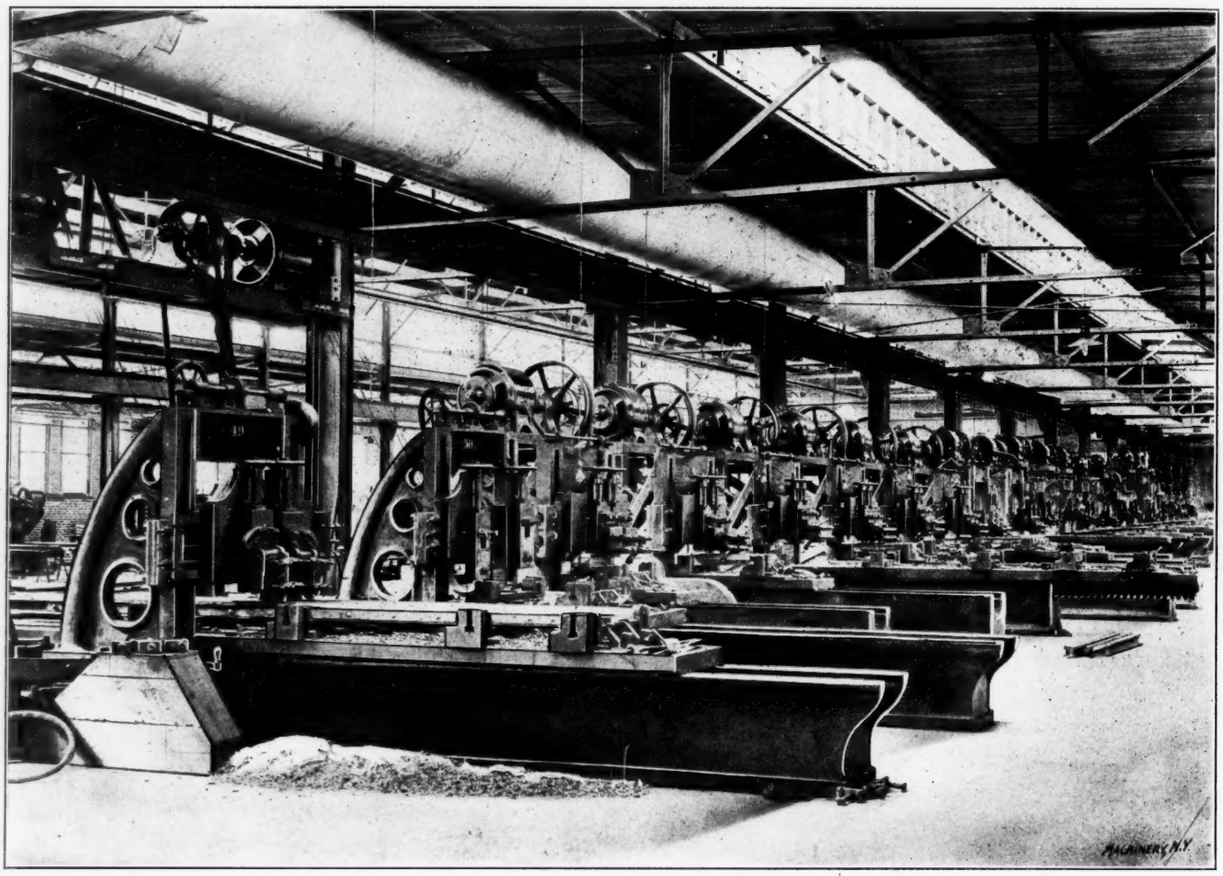

Fig. 1. A Row of Motor-driven Frog and Switch Planers.

After figuring the required horse power of the machine tools back to and including the driving motor, the loss in the electric mains back to the power plant must be figured. Formulas for this are, of course, to be had in every handbook, and will not be of interest here. If the factory is to be belt driven throughout, the friction load will vary from 40 to 50 per cent, depending on the location of the power plant, the ease of the belting scheme, etc.

The power required for lighting must, of course, be figured accurately for each particular layout; incandescents figured for 3½ watts per candle power, and arcs at 10 amperes 50 volts. In the preliminary estimate the lighting load may be assumed as between 55 and 60 per cent of the manufacturing load. The circuits should be divided into three classes—machine tool circuits, consisting of one 16-candle power lamp for each machine tool, which should be turned on by the engineer as soon as light begins to fail in the factory; day circuits, which are on throughout the entire day, consisting of one 32-candle power lamp for each office desk, drafting board, etc., and 16-candle power lamps in the storehouse and isolated parts of the factory; and general lighting circuits, which should be turned on five minutes before time of shutting down, consisting of arc lights at each elevator, stairway or main

MODERN METHODS IN THE MANUFACTURE OF RAILROAD FROGS.

The Louisville & Nashville Railway Company recently placed a contract for furnishing its entire supply of railway frogs for the coming year with a single concern, the Weir Frog Company, which possesses one of the best equipped shops for this class of work in the country. They are located at Norwood, Ohio, a suburb of Cincinnati.

The main shop is a single story brick structure 720 feet long and 125 feet wide, with a floor space of approximately 89,000 square feet. The main aisle has a span of 61 feet and the two side bays each a span of 31 feet. The roof is supported on structural steel columns and trusses. The shops are roomy and well lighted from both skylights and side windows. The windows in the side walls set 6 feet above the floor, and there is also a line of side windows set above the roof of either side bay.

The two-story buildings adjacent to the main shop structure at the south end are identical in size, 40 x 60 feet, and are used, one for general offices and drafting room, the other for service rooms fitted with men's lockers, lavatories, etc., and pattern shop and storage on the second floor. Each of these

buildings is connected with the shop by short covered passage ways.

The erecting and main machine floor is 125 feet by 340 feet, served over its entire length by two electric cranes, one of which is used largely in loading and unloading freight cars, brought into the north end of the shop building on a switching track capable of holding twelve cars, and so built that the car floors come flush with the main floor of the shop. On the main machine floor are the planers, straightening machines, and special tools of various kinds used in handling the rails for the manufacture of railway frogs. The second crane supplies the erecting floor and machines with material from the stock department which is located just beyond the erecting floor. In this department, a space of 60 x 380 feet enclosed by a fence, is kept all material received in the shops. The forge department, in the south bay, is equipped with forging machines, presses, hammers, heating furnaces, etc. In the north bay and opposite the forge department, the special tools for bending, curving and drilling rails are located.

The power plant consists of a 500-H.P. automatic compound engine, direct coupled to a 300-K.W. Allis-Chalmers direct-current generator, 220 volts. Every machine tool in the shop, with the exception of a few small machines taking power from two lines of motor-driven shafting, is driven by a separate Allis-Chalmers type "N" direct-current motor. A steam-driven air compressor furnishes 500 cubic feet of free air per minute at 90 pounds pressure, for the operation of pneumatic reamers, drills and riveters, and also for the operation of pumps.

The boiler room is equipped with two 250-H.P. water-tube boilers fitted with mechanical stokers. An artesian well, 320 feet deep, supplies all water used on the premises. It is pumped by compressed-air pumps to a storage tank 60 feet above ground, with 20,000 gallons' capacity. Water for the boilers is softened, then filtered and heated in an exhaust steam heater. The floors of the filter and boiler room are ten feet below the level of the engine room floor and eight feet below the ground level. The coal is received in hopper cars and dumped directly to the boiler room floor. The floors of the erecting and main machine shop are of concrete. The heating system utilizes exhaust steam from the engines for heating coils of pipes over which air is blown and distributed throughout the buildings.

In Fig. 1 is a view of the rather impressive row of motor-driven planers at this plant, and in Fig. 2 a general view of the erecting floor, showing the light, open construction, free from the maze of line shafting, belts and pulleys, which would go far to destroy the excellent lighting effects.

Fig. 2. Assembling Floor of the Weir Frog Company.

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TURBINE TROUBLES.

The most serious trouble experienced with the Parsons turbine has been the tearing out of more or less of the blading upon occasions when the rotor and stator came into contact through some accident, or otherwise. This type of turbine has usually been constructed with the blades unsupported at their outer ends; and consequently, when the stationary or moving vanes come into contact, or even if the moving vanes rub against the outer casing itself, it is inevitable that some of them will be torn out, and these in turn injure other blades.

The main cause for such trouble has been the distortion of the casing of the turbine, usually due, either to unequal expansion in the casing itself or in the piping leading to and from the turbine. Some of the earlier turbines had ribs underneath, forming a part of the supporting frame, which did not heat up as rapidly as the upper half of the shell, and produced distortion. The obvious remedy, which has been followed, was to abandon this construction and make the shell as symmetrical as possible. Also, the remedy for strains due to unequal expansion in the piping is the same as has been applied in steam-engine practice, namely, the introduction of corrugated expansion joints.

Still another cause for distortion is the pull—or more properly, the pressure—upon the casing due to the vacuum in the condenser. This amounts to some 13 or 14 pounds per square inch and when applied to the large area of the opening leading to the condenser produces a heavy stress within the casing. An ingenious plan for overcoming this has been adopted in Europe and to some extent in this country. It consists in placing the condenser under the turbine and suspending it from the turbine by bolting it solidly to the casing, while the turbine itself is supported on an independent foundation. The weight of the condenser is then taken by a flexible foundation consisting of some type of springs. This not only relieves the turbine of any stress due to the weight of the condenser, but prevents any possible distortion due to the "pull" of the vacuum.

COLLAPSING PRESSURES OF BESSEMER STEEL LAP-WELDED TUBES.

A series of very elaborate experiments has been carried on at the McKeesport works of the National Tube Co. to determine the behavior of modern wrought tubes when subjected to fluid collapsing pressure. The experiments were conducted on an extensive scale under the direction of Prof. Reid T. Stewart, Allegheny, Pa., and required for their completion the time of from one to six men during a period of four years.

A carefully-prepared and very full account of these experiments formed the subject of a paper by Prof. Stewart before the Chattanooga meeting of the American Society of Mechanical Engineers. The completeness of the paper may be judged from the fact that it contained 87 pages and 58 diagrams, tables and illustrations.

Preparatory to entering upon the research, all existing published formulas that could be found for collapsing pressures were collected, most of which appeared to be based upon Fairbairn's classical experiments made more than half a century ago upon tubes wholly unlike the modern product. Without exception these formulas gave results differing widely from the pressures observed during these tests. As an illustration of this, the very first tube tested failed under a pressure that exceeded by about 300 per cent that calculated by Fairbairn's formula.

Two series of tests were conducted. The first was on tubes that were 8⅝ inches outside diameter, for all the different commercial thicknesses of wall, and in lengths of 2½, 5, 10, 15 and 20 feet between transverse joints tending to hold the tube to a circular form. The chief purpose of this series of tests was to furnish data for determining which of the existing formulas, if any, were applicable to modern lap-welded steel tubes, especially when used in comparatively long lengths, such as well casing, boiler tubes and long plain flues.

The second series was made on single lengths of 20 feet between end connections tending to hold the tube to a circular form. Seven sizes, from 3 to 10 inches outside diameter, and in all the commercial thicknesses obtainable, have been tested to date. The chief purpose of these tests was to obtain, for commercial tubes, the manner in which the collapsing pressure of a tube is related to both the diameter and thickness of wall.

The principal conclusions to be drawn from the results of the research may be briefly stated as follows:

The length of tube, between transverse joints tending to hold it to a circular form, has no practical influence upon the collapsing pressure of a commercial lap-welded steel tube so long as this length is not less than about six diameters of tube.

The formulas, as based upon the present research, for the collapsing pressure of modern lap-welded Bessemer steel tubes, are as follows:

$$P = 1{,}000\left(1 - \sqrt{1 - 1{,}600\frac{t^2}{d^2}}\right) \qquad \text{(A)}$$

$$P = 86{,}670\frac{t}{d} - 1{,}386 \qquad \text{(B)}$$

Where P = collapsing pressure, pounds per square inch.
d = outside diameter of tube in inches.
t = thickness of wall in inches.

Formula A is for values of P less than 581 pounds, or for values of $\frac{t}{d}$ less than 0.023, while formula B is for values greater than these.

These formulas, while strictly correct for tubes that are 20 feet in length between transverse joints tending to hold them to a circular form, are, at the same time, substantially correct for all lengths greater than about six diameters. They have been tested for seven diameters, ranging from 3 to 10 inches, in all obtainable commercial thicknesses of wall, and are known to be correct for this range.

The apparent fiber stress under which the different tubes failed varied from about 7,000 pounds for the relatively thinnest to 35,000 pounds per square inch for the relatively thickest walls. Since the average yield point of the material was 37,000 and the tensile strength 58,000 pounds per square inch, it would appear that the strength of a tube subjected to a fluid collapsing pressure is not dependent alone upon either the elastic limit nor ultimate strength of the material constituting it.

For the convenience of those who wish to apply these formulas, the charts reproduced on the next page were prepared.

The first chart, Fig. 1, shows the probable collapsing pressures for lengths greater than six diameters of National Tube Co.'s Bessemer steel lap-welded tubes, plotted to thickness of wall.

The second chart, Fig. 2, is for obtaining probable collapsing pressures from values of thickness ÷ diameter (t/d), for lengths greater than six diameters.

While planning this research it was assumed that the resistance offered by a tube to an external fluid pressure would depend upon the following five things, namely:

1. The diameter of the tube.
2. The length of tube between transverse joints or end connections tending to hold it to a circular form.
3. The thickness of the wall.
4. The deviation of the tube from perfect roundness.
5. The physical properties of the material of which the tube is made.

Of these five things that may vary it was thought that, for the preliminary experiments, at least, Nos. 4 and 5 would be practically constant; No. 4, because the tubes being all made by the same process, would probably run fairly uniform as to deviation from roundness, and No. 5, because the material in this case being Bessemer tube steel, is known to run fairly uniform in its physical properties. The physical tests would, of course, serve as a check upon this latter.

The only variation, then, to be expected in Nos. 4 and 5 would be that due to the inability of the manufacturer to turn out a uniform product. It is recognized here that the physical properties of rolled steel depend in some measure, other things being equal, upon the thickness of the plate; or, in this case, upon the thickness of the wall of the tube. It is clear that any variation would be a function of the thickness, and would consequently be taken care of in an empirical formula by the quantity representing the thickness.

The influence of length of tube between transverse joints, or end connections tending to hold it to a circular form, upon the collapsing pressure, appeared to be the most uncertain of all the variables entering the problem. It was therefore decided, first of all, to determine the precise nature of this influence.

The apparatus in which the tubes were subjected to an external fluid pressure was designed and built for this research and comprised the following main features:

1. A test cylinder with one head removable for the reception of the tube to be tested, this cylinder being provided with means for creating an hydraulic pressure within, thus subjecting the tube under test to a fluid-collapsing pressure.
2. A low-pressure water supply of large volume to rapidly fill the space within the test cylinder not occupied by the tube under test.
3. A variable high-pressure water supply furnished by an hydraulic-pressure pump, the purpose of which was to create a fluid pressure within the test cylinder, the tube under test by this means being subjected to a gradually increasing fluid-collapsing pressure.
4. A set of pressure gages, having a large range in capacity, connected so that they could be used either singly for indicating the fluid pressure within the test cylinder or in combination for comparison.
5. A vent pipe leading from the interior of the tube under test through the head of the test cylinder to the atmosphere, in order to maintain constantly an atmospheric pressure within the tube being tested.
6. An air vent connecting with the highest point of the interior of the test cylinder, in order to thoroughly free from air the interior of the test cylinder, while being filled with water, after the insertion of a tube to be tested.

Test cylinders of two different diameters were employed, one 16 inches and one 8 inches in diameter. The former was originally made up in three sections having a total length of

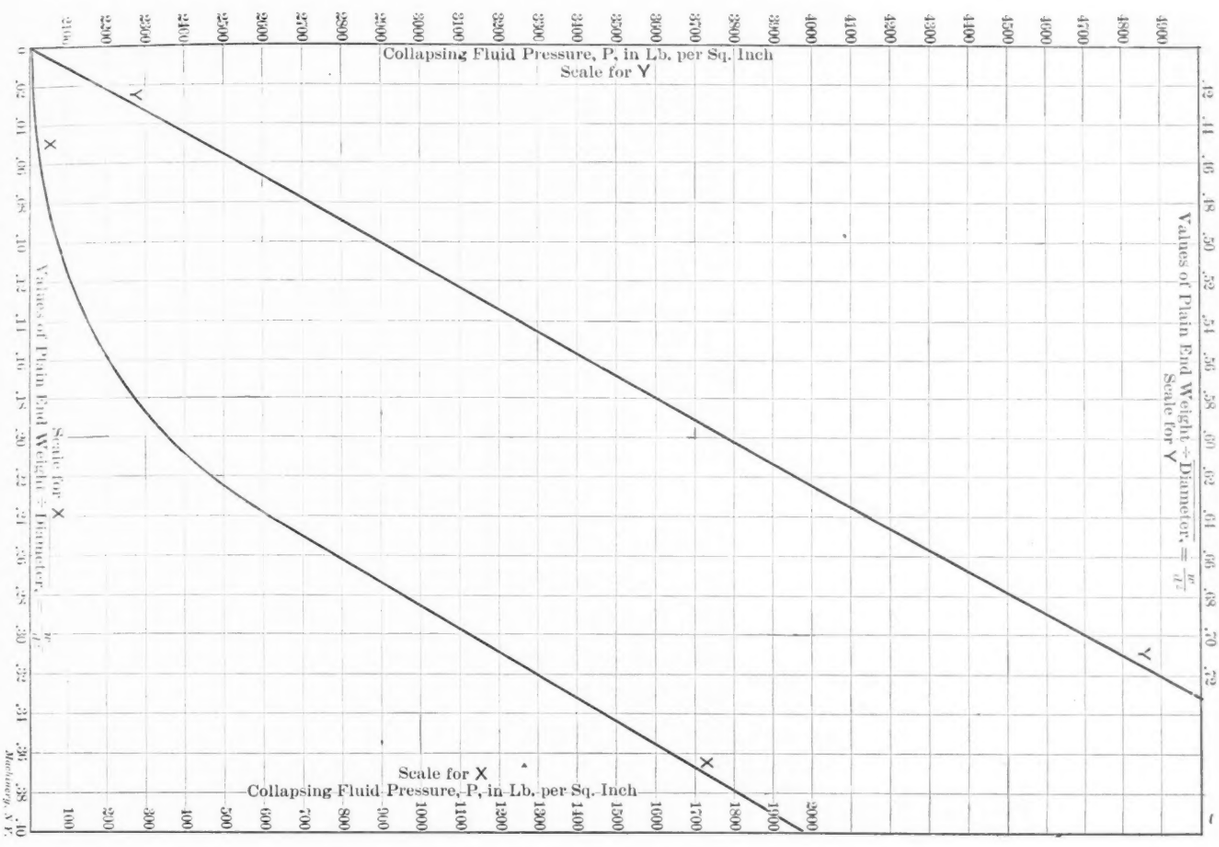

Collapsing Fluid Pressure, P, in Lb. per Sq. Inch
Scale for Y
Values of Plain End Weight ÷ Diameter, = w/d
Scale for Y
Scale for X
Collapsing Fluid Pressure, P, in Lb. per Sq. Inch
Values of Plain End Weight ÷ Diameter, = w/d
Scale for X
Machinery, N.Y.

Fig. 1. Chart showing Collapsing Pressures for Lengths Greater than six Diameters Plotted to Thickness of Wall.

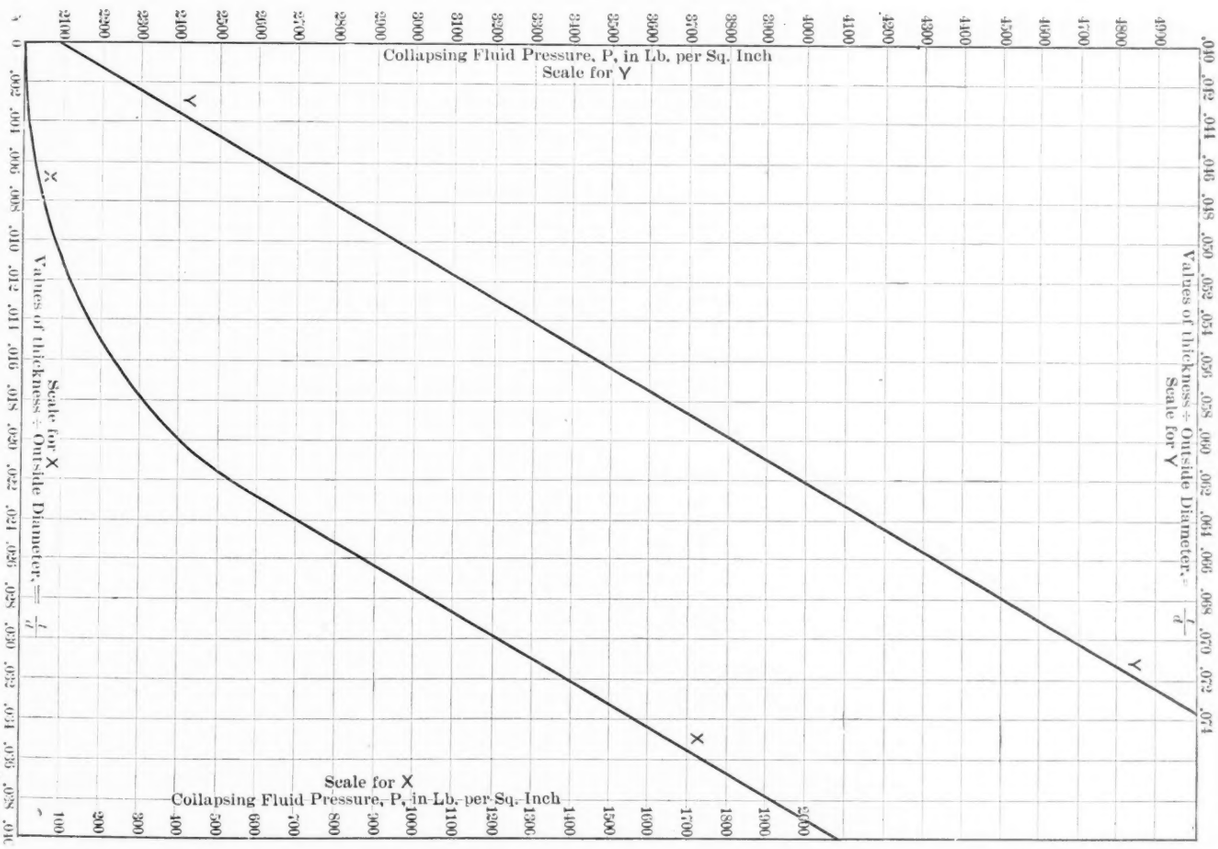

Collapsing Fluid Pressure, P, in Lb. per Sq. Inch
Scale for Y
Values of thickness ÷ Outside Diameter, = t/d
Scale for Y
Scale for X
Collapsing Fluid Pressure, P, in Lb. per Sq. Inch
Values of thickness ÷ Outside Diameter, = t/d
Scale for X
Machinery, N.Y.

Fig. 2. Chart for obtaining Collapsing Pressures from Values of Thickness ÷ Diameter for Lengths Greater than six Diameters.

45 feet, the intention being to have it long enough to accommodate a string of well casing consisting of either two full lengths of 20 feet each, including three couplings, or one full length of 20 feet, with a half length coupled to each of its ends. It was soon discovered that the behavior of a tube in collapse was such that precisely the same results could be had from a single 20-foot length as from either of the above arrangements. Because of this the cylinder was shortened at the first opportunity, by the removal of the intermediate section, to a length of about 30 feet.

The 8-inch cylinder was for testing 3 and 4-inch tubes and was 20 feet long. It was arranged somewhat differently from

the 16-inch cylinder, but embodied the same principles and the 16-inch cylinder, Fig. 3, will be the only one illustrated herewith.

The rear end of the 16-inch test cylinder was connected, as shown in Fig. 3, to the low-pressure water supply of the works for the purpose of rapidly filling it. An air vent was provided at the top of the left-hand head.

The pressure within the test cylinder was created by means of a hydraulic-pressure pump capable of working against a fluid pressure up to 3,000 pounds per square inch. Ordinarily this pump was operated, upon entering the region of expected collapse, so as to increase the fluid pressure at a rate of from

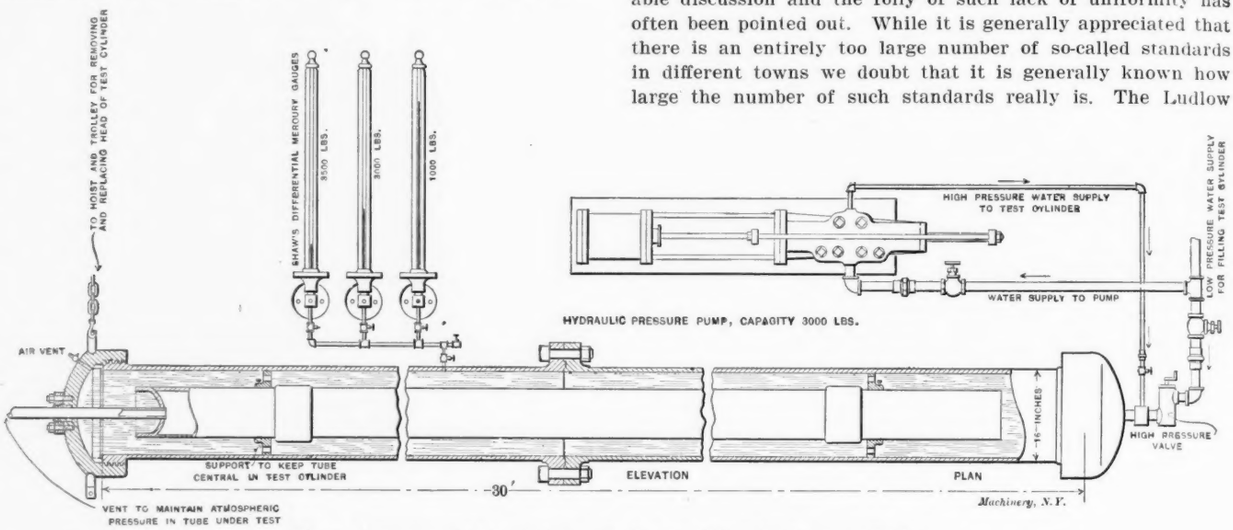

TO HOIST AND TROLLEY FOR REMOVING AND REPLACING HEAD OF TEST CYLINDER
SHAW'S DIFFERENTIAL MERCURY GAUGES
8500 LBS.
3000 LBS.
1000 LBS.
HIGH PRESSURE WATER SUPPLY TO TEST CYLINDER
WATER SUPPLY TO PUMP
LOW PRESSURE WATER SUPPLY FOR FILLING TEST CYLINDER
HYDRAULIC PRESSURE PUMP, CAPACITY 3000 LBS.
AIR VENT
16-INCHES
HIGH PRESSURE VALVE
SUPPORT TO KEEP TUBE CENTRAL IN TEST CYLINDER
ELEVATION
PLAN
30'
VENT TO MAINTAIN ATMOSPHERIC PRESSURE IN TUBE UNDER TEST
Machinery, N.Y.

Fig. 3. Arrangement of Apparatus for Finding the Collapsing Pressure of Tubes.

about 2 to 10 pounds per second, depending upon the gage used. At these rates of increase of pressure the conditions were favorable for the making of an exact determination of the fluid pressure under which the tube failed.

The gages used for indicating the pressure at instant of collapse were three Shaw differential-piston mercury gages, having capacities of 1,000, 3,000 and 8,500 pounds per square inch. They were connected in the manner shown in Fig. 3, so that, by opening or closing suitable valves, any one or more of them could be connected to the test cylinder for the purpose of indicating the pressure therein.

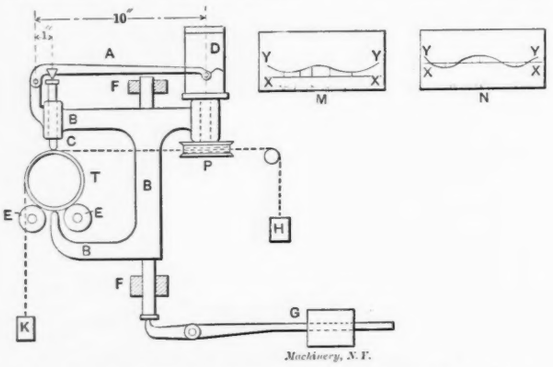


Fig. 4. Instrument for Measuring Out-of-roundness of Tubes.

Since it was anticipated that the out-of-roundness of the tube under test would exert a controlling influence on its behavior, it was thought best to devise a piece of apparatus to indicate this deviation from perfect roundness with great accuracy. A number of schemes for accomplishing this was worked out, one of which is illustrated in Fig. 4.

The tube, while being calipered, is rotated on supporting guide wheels, *E E*, by means of the guides *F F* and the counterbalancing lever and weight *G*. The lower calipering point is constantly kept in contact with the tube while it is being made to rotate. Any variation in the vertical diameter of tube is indicated by the motion of the upper calipering point *C*; which variation is magnified ten-fold and recorded on the drum *D* by means of the pencil mechanism *A*.

The recording drum *D* and the tube *T* are made to rotate synchronously by means of a cord weighted at both ends and passing once around both of them. The curve *Y Y* is produced by one revolution of the tube and *X X* by replacing the tube by a distance piece between the calipering points equal in size to the nominal diameter of the tube being tested, the distance between these lines showing to scale the variation of actual from standard diameter for any given cross section.

* * *

The confusion of sizes of hydrant nozzles for cities and towns of the United States has been the subject of considerable discussion and the folly of such lack of uniformity has often been pointed out. While it is generally appreciated that there is an entirely too large number of so-called standards in different towns we doubt that it is generally known how large the number of such standards really is. The Ludlow Valve Mfg. Co., of Troy, N. Y., have a gage room containing nothing but hydrant nozzle standards for about 7,000 cities and towns, most of which are in the United States, a few being in Canada and England. In this room there are (or were in January) 889 nozzle sizes, all different, where three, or at most, five standard sizes would be sufficient. Standard nozzle connections for 2, 2½, 3, 4 and 4½-inch hose would be practically all that is necessary for almost any town or city, and if such standards could be adopted it would mean that concerns like the Ludlow Co. could make hydrants an article of standard manufacture, whereas they are now made to order only, for the lack of uniformity in nozzles makes it impossible to carry a stock of these goods, except it may be for cities like New York, Boston, or Chicago, whose standards have been widely copied. Consequently the cities have to pay a higher price for hydrants and at the same time often run the risk of not being able to call on neighboring towns in case of disastrous fires.

* * *

A feature of incandescent electric lighting in shops and factories that has been greatly neglected is the provision of proper connections from the wire mains to the lamps used on the machines. The common practice has been to carry a double flexible cord from the nearest lamp socket to a portable lamp hung on some rickety fixture attached to the machine. That this practice is not only slovenly but dangerous besides has been frequently proven by the unfortunate experience of operators who have been badly shocked or burned by short circuits. Not only this, but the use of lamp cord in such a manner is wasteful; it lies around on the floor where the insulation is bruised and soon destroyed, and the amount of cord that may be needlessly used up in a large shop in the course of a year is a considerable item. Where proper attention is given to this feature of machine shop equipment the machines are wired the same as a building, the wires being carried up inside the columns of the machines in insulated cables, and sockets are provided at various convenient points in which a plug, connected to a short length of flexible cord, can be inserted. The nearest socket, of course, is used to suit the convenience of the work. With machines wired in this way the length of flexible cord required is short.

ELEMENTARY DIALING.

JAMES ARTHUR.

The sundial is probably the oldest means of marking time, and its history is lost in the remote past. The moving shadows of fixed objects must have been observed by primitive man as indicating the passage of the day, and a very natural step after this was to place marks to be reached successively by the shadows; thus dividing the day into periods, ultimately settling down to our twenty-four-hour method. To-day farmers in out-of-the-way places have their "noon marks" reached by the shadow of a tree trunk or other fixed object; and as any *vertical* object gives noon just as accurately as a dial the method is still good.

Fig. 1. A Round-faced Dial for Latitude of New York.

Among the ancient references to dials is that to "The Dial of Ahaz" in the Old Testament, and it would be pretty safe to say that that was the only one on which the sun ever went backwards. Coming nearer our times, dials cut on stone become numerous and those cut on the walls of churches and public buildings are comparatively modern. A very quaint one of this kind may be seen in Amsterdam, Holland, and one on the old church in St. Augustine, Florida.

The old cyclopedias nearly always had a large section on "Dialing," and their steel and copper plate engravings were often equal to our best work of to-day. Among books on dials may be mentioned "Sundials and Roses of Yesterday" by Earle and "The Time Piece of Shadows" by Spackman, both rich in illustrations.

The development of the modern clock caused the dial to decline to a garden ornament, but within a few years there has been a distinct revival, and this is good; for the dial and its supporting column give opportunities for original and artistic treatment to an unlimited extent. As a scientific amusement the construction and setting of dials could hardly be surpassed; since the higher branches require astronomical and mathematical knowledge. The fundamental principles, however, are simple, as I shall try to show.

Referring to Fig. 2 let *N E S W* represent a great circle of the earth corresponding with the meridian of New York City Hall. *S N* is the axis, and at the north pole, *N*, we will erect a horizontal dial, as shown at *A B*, and lining with the axis is the vertical wire *C*, forming the "style" of the dial, being the part which casts the shadow on the dial plate *A B*. We will assume that the earth rotates exactly in twenty-four hours. In midsummer when the sun's rays fall on this dial as per arrow *C* the shadow at 12 noon (or when the sun passes the New York meridian) would fall towards *B* on the 12 o'clock line of the dial. Now, if this dial is divided equally into 24 parts, the shadow of the style *C* will fall on the lines uniformly each hour for the entire 24 hours, since the sun does not set on the north pole during our summer. If you will stick a pin in the center of Fig. 3 you will have this dial. Now we will erect a dial the same on the equator at *W*, but we must keep the same relative position to the axis of the earth and the equator, that is, the style *C' C''* must be parallel to the axis *S N* and the dial plate *A' B'* parallel with the equator, *W E*. The beginner must grasp these elementary steps thoroughly before proceeding further, viz., that any number of dials of this pattern may be erected on the surface of the earth with the plates parallel to the equator, and wires, or styles, parallel to the earth's axis, and that they are all divided into twenty-four equal spaces for the hours, and will mark the sun time. In the case of the dial at *W*, the effect is the same as if the twenty-four-hour rotation took place on the line *C' C''* and similarly with all the dials. Note that the dial at *W* is fastened by its edge to the column so as to get it in the same relative position as the north pole dial at *N*. The dial at *W* is double, so that the summer sun as per arrow *C''* falls on its north side, while the sun at the Equinox falls on its edge as per arrow *A'* and during winter on the south side as per arrow *C'*. This is all very simple; the styles standing up square in the centers of the dials and the twenty-four hours divided equally like the spokes of a wheel, as *K R L Q* in Fig. 3. This brings us to the point which puzzles many persons of education, that is the varying spaces of the hours on a horizontal dial at New York. At *D* (which is the latitude of New York, 40 degrees 43 minutes) is shown a regular horizontal dial, *H I*, the style *F G* being *parallel with the earth's axis, S N*, and this is the universal and necessary characteristic of all true dials; so the three dials described all have their styles pointing to the pole star, and dials may be set on a clear night by viewing the edges of their styles to the pole star.

To illustrate the fact that all dials have their lines equally divided, refer to Fig. 3, representing a cylinder, side elevation, *J K*, and end elevation *K L*, which we will suppose to be built up of white wood in twenty-four sections, 1, 2, 3, 4, etc., all glued up with dark-colored glue. The end of this cylinder *K L* represents the two dials *W* and *N*, Fig. 2, the glued joints being the hour lines. Now cut this cylinder on line *M O*,

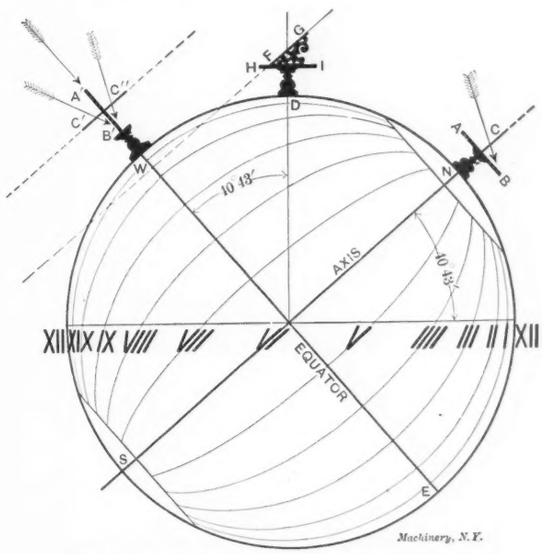


Fig. 2. The Basic Principle of the Sun Dial Illustrated.

being 40 degrees 43 minutes to its axis *J K* and the section will be the ellipse Fig. 4, which is a horizontal dial for New York. To show that these lines are correct, a dial of ordinary proportions is shown within the elliptical section, its hours being the glued joint lines.

Further, cut the cylinder to the latitude of any place you please and the section will be a horizontal dial for that place. Still further, you may cut it irregularly, as per line *P*, like the face of a rock at the seashore and it will be a correct dial. You may even turn it on its axis *J K* and set any of the glue joints on the meridian and mark that joint 12 o'clock and it will still be correct. Only one thing you cannot change: the axis *J K*, which we will assume to be a stiff wire, *must be parallel to the earth's axis.*

Imagine the globe, Fig. 2, to be glued up of twenty-four

sections, the meridians being the joints. If this globe is cut on line *XII*, it will give the lines for a horizontal dial at New York the same as Fig. 4, the axis *VI*, *N* being the style of this eight-thousand-mile dial, but this might look a little more difficult to the beginner. This explains the very irregular lines on dials which are cut on the walls of buildings or even on the face of a rough rock cliff. Set up a round stiff rod pointing to the pole star or a solid piece with its edge

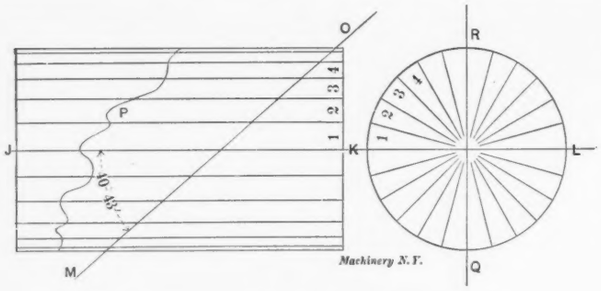


Fig. 3. Development of Dial for Latitude of New York.

so pointing. Now, project imaginary planes from this rod or edge by viewing it at intervals of 15 degrees, but take the first view north for your 12 o'clock line. Where the planes (or views) cut surrounding objects, such as the wall of a building, a rock, or a pavement, cut or paint lines and you have a correct dial. Some of these lines would look very wild, but viewed from the style as the shadow strikes them they are straight lines, just like the glued joints in Fig. 3. All this is to establish the fact that the hours are angles of 15 degrees (or one twenty-fourth the circle) evenly divided around the style. But this glued-up cylinder is only a graphic illustration and need not be made. Let *T*, Fig. 5, be a solid cylinder mounted in the milling machine as shown and milled off to 40 degrees 43 minutes on section *V U*, being the same as section *M O* on Fig. 3. Set the machine to 24 and scratch off hair lines by the surface gage *X* as you register each twenty-fourth and the result will be exactly Fig. 4, which is a New York

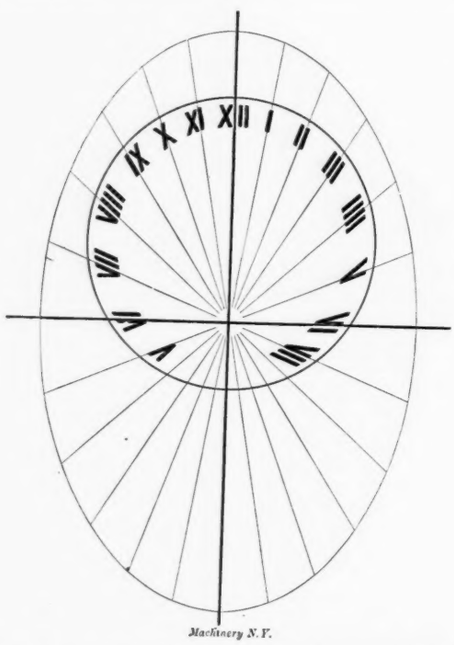


Fig. 4. Showing the Part of the Elliptical Section used in a Dial Face.

horizontal dial. One step more, even the portion of a cylinder, *T*, is not necessary, but is intended to keep the illustration clear. Any piece of wood or metal fastened to the face plate of the machine in place of *T*, so long as you can mill a portion of it off to angle *V U* will be sufficient. Now place on this surface a polished brass plate, *V U*, and proceed to scratch hair lines on it by surface gage and you will have a *master dial plate* for New York, from which dials may be made in any number by mere copying. In other words, when you understand the fundamental principle you may fasten the master dial plate in the machine by any blocking or angle pieces at hand, but it must be 40 degrees 43 minutes to *axis of the dividing head* if you want a New York horizontal master dial.

These hair lines made by the surface gage, of course, require to be cut in a little by using a steel straightedge and a hard sharp point, so as to make this master dial permanent. So far this is done by the milling machine as in general use, but an attachment can be designed which would enable us to mount the dial plate parallel with the table of the machine and then the lines could be cut in by the machine just as we now engrave degrees on a circle. With this attachment, which could be set to the latitude of any desired place, we would have what might be called a dial-engraving machine.

Fig. 1 is a photo-engraving of a complete horizontal dial for New York City made in every respect as described, the lines being engraved on the milling machine. Fig. 6 has same lines, but projected on a square plate, which is merely a matter of taste, as the dial plate may be of any plain or fanciful shape.

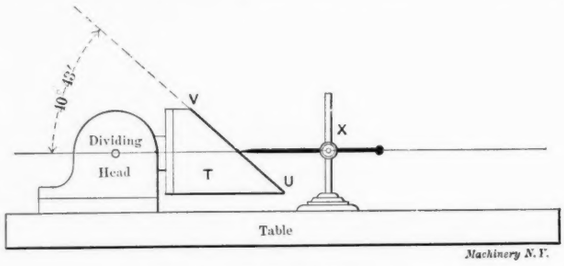


Fig. 5. Scribing the Master Dial.

The books contain methods of laying down a dial on the drawing board, but this method in the milling machine is as accurate as the machine itself and for practical purposes perfect, and free from the personal error in laying down intersecting lines and then drawing final lines through these intersections. It is hardly necessary to point out that for half hours, quarters and five-minute marks the same methods apply, but as this is an elementary chapter on dialing the illustrations are simpler and clearer by showing only hours. For quarter hours set the machine to 96, and for five-minute marks to 288. For similar reasons the variations in sun time, amounting to about half an hour during the year, corrections

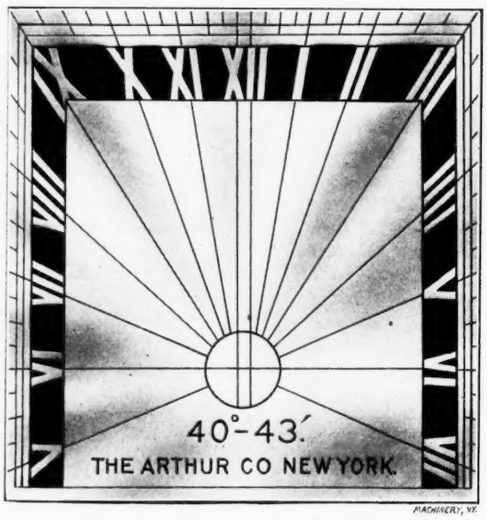


Fig. 6. An Alternative Design of Dial.

for position of "pole star" and errors caused by atmospheric refraction, etc., as well as minute practical instructions for making and setting up dials cannot be gone into here.

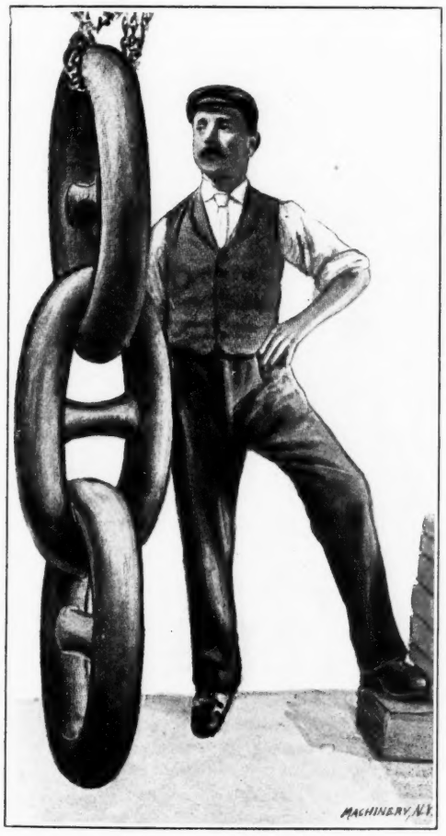
[We consider the foregoing article unique, being, as it is, on the theory of the oldest and most primitive device known to man for marking time, and at the same time showing a scientific method of using a modern machine tool—the milling machine—to lay out a master dial plate for any latitude. The sun dial is an interesting example of projection, the normal

dial, as explained, being an evenly divided 24-space circle at right angles to the polar axis, while the working dial is a projection of the normal dial on a plane tangent to the earth's radius for whatever latitude required. The described method of projection for making the master dial uses a milling machine dividing head in which a wooden block is held and milled off at the required latitude angle to support the master dial blank during the marking off process. Making the supporting wooden block a composite structure with twenty-four sectors simply showed the principle clearer. The transfer of divisions from the master dial to a working dial is readily done with dividers. Mr. Arthur, the writer of the article, as some of our readers know, is a machine shop proprietor in New York City, who is employing part of his leisure time in the study and construction of various horological devices, and the sun dial is the type of timekeeper which he has only recently taken up; and this he is attacking in a characteristically thorough manner. The writer has seen the master plate made for the latitude of New York City, and a demonstration of the method by which it was laid out. It is obvious from the foregoing description that this simple mechanical method of projection eliminates the liability of error, which, of course, is present in the ordinary drawing board method. It should not be inferred, however, that a slight error is of any great consequence in a sun dial, but it is of interest to know that Mr. Arthur has gone at the construction of this ancient timekeeper by scientific and accurate machine shop methods, doing what is probably absolutely new and unique in this direction. —EDITOR.]

* * *

HEAVY CHAIN CABLE FOR NEW CUNARDERS.

The accompanying half-tone cut taken from *Pages Weekly* shows three links from a cable forged by Brown, Lennox & Co. for the new Cunard turbine steamers. The links of these cables are made of 3¾-inch iron and are each 22¼ inches long, the weight being 160 pounds per link. The three links



Links Weighing One Hundred and Sixty Pounds Each.

shown in the illustration were taken for the Admiralty test, and when subjected to a load of 350 tons, did not give way. In fact they were tested with a pull of 370 tons without fracture. Each of the two new Cunarders has two of these cables, each measuring 80 fathoms long, or 480 feet.

W. R. ECKART.*

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Prominent among the able engineers who have contributed largely to the material development of the Pacific Coast stands the name of W. R. Eckart, a man who has stamped his character on much of the foundation work that underlies the splendid structures reared by engineers on the side of our country that faces the Pacific. For the past forty years Mr. Eckart has had some part in the solution of nearly all the great problems that have confronted the mechanical engineer in the development of the material prosperity of the Pacific Coast, and as he began to work on these problems when quite young in his profession, nearly all his fellow workers have now solved the final problem of life. The writer has known Mr. Eckart for over thirty years, working both with and against him in that time, and can bear record to the fact that a good fight with Mr. Eckart was worth something as an education, and to work with him was worth more as an inspiration.

Mr. Eckart was born in Chillicothe, Ohio, June 17, 1841. His relations on the mother's side were pioneers in the settlement of that portion of the State. About 1842 his parents moved to Cleveland, where his father, who was a merchant, had large shipping interests in vessels on the lakes. Young Eckart's education began in private schools. His mother died when he was twelve years of age, and after that his school days were divided between the public schools of Chillicothe and Cleveland, after which he took a special course in mathematics at the St. Clair Street Academy in Cleveland, with the idea of following the profession of civil engineering, one of his relatives being an eminent civil engineer and president of the Marietta and Cincinnati Railroad.

About the middle of the fifties, Mr. Eckart's father moved to Zanesville, Ohio, where he had a managing interest in the Putnam flour mills, the power for which was derived from six waterwheels, each wheel driving "one set of burrs." It was while assisting the millwright in installing improved waterwheels in this mill that he was offered the opportunity to serve an apprenticeship in the works of Griffith, Ebert & Wedge, an establishment that had a high reputation in those days for general mill and steamboat work. The fascination of steamboat engineering had already taken hold of young Eckart while traveling on the Ohio and Mississippi River boats, and he gladly accepted this opportunity. During his apprenticeship Mr. Eckart had the good fortune to secure the friendship of the junior partner and manager of the works, Mr. Wedge. He was a master mechanic of great ability, who had been an apprentice and foreman to Sir Joseph Whitworth when the latter was making known to the world, in his Whitworth works, England, the most accurate methods of machine

* Contributed by Geo. W. Dickie.

tool construction. Mr. Wedge had already installed many of the Whitworth methods of producing accurate work in their shops at Zanesville. Mr. Eckart says that an apprentice was not allowed to pass judgment on his own work as being "good enough." "Good enough," according to Mr. Wedge, was "half spoiled." He always had the patience and the time to show the young mechanic how to make better what he thought was "good enough." Mr. Eckart's reputation for accurate and painstaking work on the smallest details was, no doubt, the result of this early training under Mr. Wedge. He says, "The lesson of patience and accuracy was forcibly impressed upon me at the beginning, when, after a whole day's work devoted to the dressing and finishing of one hexagon nut, I found that it would not pass Mr. Wedge's inspection. His criticism was not finding fault, but a hint to try again. 'You can do it,' and we always got what he wanted in the end, by trying."

Mr. Eckart, while an apprentice, made numerous trips from the works on the trials of new river-boat engines, which resulted in a desire to enter the service of the government as a naval engineer. He applied for permission to be examined as to his qualifications, and at the breaking out of the Civil War he was ordered to appear for examination, June, 1861, and on July 2 he was examined by a board of engineers, of which William H. Shock, chief engineer, was president. His mathematical training, in connection with his shop and steamboat experience, enabled him to pass the examination as No. 1 of his date. It was at this examination that Mr. Eckart met and formed a life-long friendship with the late Prof. R. H. Thurston.

He was appointed third assistant engineer on July 30, 1861, and was ordered at once to join the fleet of naval vessels on the Pacific Coast. While attached to the government vessels in San Francisco harbor in the latter part of 1861, the bright young engineer attracted the attention and made lasting friendships with many of California's foremost men in the engineering profession, including such men as Paul Torqua, Joseph Moore, Irving M. Scott, Wallace Hanscom, Huttner, Specht, and others who did noble work in the engineering development of the Pacific Coast. In July, 1864, Mr. Eckart resigned from the navy on account of ill health and settled in San Francisco. His first work was in the drawing room of H. J. Booth & Co., under the late Irving M. Scott, who was chief draftsman. The principal work in those days was the manufacture of mining machinery and repair work on coast steamships.

On August 30, 1865, the first California-built locomotive was turned out by H. J. Booth & Co., and went on its trial trip from the Mission, San Francisco, to San Jose. The Governor of the State and a large number of officials, on the invitation of the builders, attended the notable event. The designs and drawings for this locomotive were made by Mr. Eckart, chief draftsman for that firm. While on a visit east in 1867 he was examined for and licensed as a first-class chief engineer in the merchant service. He returned the same year to H. J. Booth & Co., and remained with that firm, designing mills and mining machinery, until February, 1869, when he received the appointment of draftsman to the Steam Engineering Department at Mare Island navy yard. Later he was appointed foreman machinist and finally promoted to the position of superintendent of steam machinery, through B. F. Isherwood's recommendation. It was at this time that Mr. Eckart designed the steam machinery, propellers, and dynamometers, for experimental purposes on steam launch No. 4. This boat was undergoing an extensive series of experiments, which created considerable interest at the time, "on the relative efficiency of different propellers"—made by Mr. Isherwood and Mr. Eckart. Records of these tests were published at the time by Mr. Isherwood in a report to the Secretary of the Navy, and by Mr. Eckart in the Transactions of the Institution of Naval Architects, London, 1872, Vol. XIII.

In 1871 Mr. Eckart left the navy yard and the service of the government to enter into partnership with Prescott, Scheidel & Co., at the Marrysville foundry (G. W. Prescott being one of the firm of H. J. Booth & Co.). The name of the Marrysville firm was afterward changed to Booth & Eckart. This foundry being close to the California mines of that time, designed and built a very extensive variety of hydraulic milling and mining machinery. It was while there, with the knowledge gained from experiments on steam launch No. 4, that he was enabled to contract for, and guarantee a speed of 21 miles an hour for the steamer *Meteor*, built for the Carson Lumber Co., to be used on Lake Tahoe. This was, perhaps, the fastest boat of her size known at that date.

In 1872 Mr. Eckart acted as consulting engineer for Sutro in sinking the four air shafts on the line of his tunnel. The investigations then made were a great help later on, both to himself and others who had access to the data collected. It was at this time that the writer of this sketch, then engineer for the Risdon Iron Works, first met and learned to appreciate the ability of Mr. Eckart, not only as a practical master mechanic, but also as a student of engineering problems. At this time he spent months in Virginia City experimenting, taking cards from pumps where the water handled was hot enough to "boil an egg" and the vapors "air-bound the pumps," while the expansion and contraction strains, due to changes of temperature, often wrecked the heaviest castings. The data he collected at this time was of great value to the firm he represented in getting up the designs for the large draining and hoisting plants built by them, such as the Belcher, Yellow Jacket, Ophir, C. and C., and many others.

In the beginning of 1873 Mr. Eckart took up his residence in Virginia City, and became consulting engineer to the "Bonanza firm," consisting of J. W. Mackey, J. C. Flood, J. J. O'Brien and James G. Fair, who owned or controlled nearly all of the "North End" mines. He also acted as manager to the Fulton Foundry. About 1876 large pumping and hoisting works began to be required on the Comstock and the firm of Prescott, Scott & Co., having taken some large contracts for pumping machinery, sent Mr. Eckart to San Francisco to superintend the construction, and to give his valuable aid to Mr. I. M. Scott in the designing of these huge machines. At this time there was a keen rivalry between the Risdon Iron Works and Prescott, Scott & Co. The firm who got in a satisfactory design first obtained the contract, hence the value of a good man like Mr. Eckart, who had been gathering data carefully for the time when it would be needed badly, was appreciated. The Sutro tunnel was, at this date, in 15,500 feet, and with 5,000 feet more to go it would pierce the Comstock lode not lower than the 1,600-foot level. The mine owners already realized that nothing but the heaviest and best-designed machinery would assist them on all the levels yet to be opened below the tunnel, and therefore designs for pumps and hoists of large capacity to reach 4,500 feet below the surface were called for. The difficulties attending the ventilation and sinking of the shafts in virgin ground, which abounded in large but unknown quantities of warm and hot water, were unparalleled in any engineering experience in any part of the world. Such was a part of the engineering requirements to be met and overcome at this early date. The writer considers it very unfortunate that no history of the engineering work done on the Comstock between the years 1875 and 1882 has been written, and Mr. Eckart is one of the few engineers now living who is qualified to write such a history.

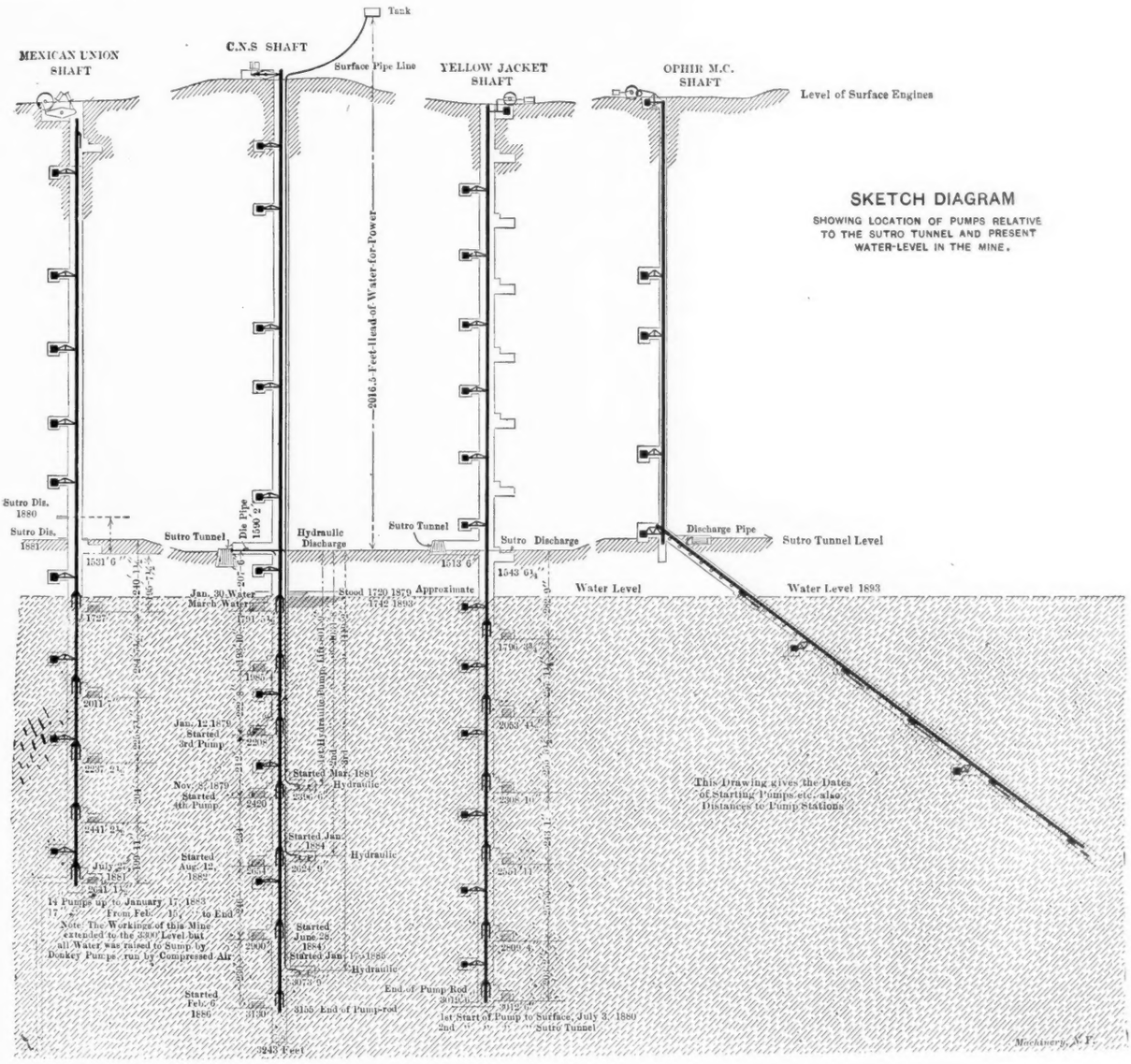
It was about this time that Mr. Eckart was made manager of the Fulton Foundry, Virginia City, and was also appointed October, 1878, Deputy Mineral Surveyor for the State of Nevada. During the following two years a large part of his time was occupied in the underground workings of the Virginia and Gold Hill mines, investigating, planning, repairing, and improving the pumps and machinery, as the mines grew deeper and the flow of water increased.

While still a resident of Virginia City, Mr. Eckart designed, and in connection with W. I. Salkald, contracted for and built, the Bulwar Standard Mill at Bodie. This was one of the largest pan mills for working ore built at that time. During the early part of 1880 he was appointed a member of the United States Geological Survey under Clarence King and was given charge of investigating and reporting upon "The Mechanical Appliances of the Comstock Lode." This was congenial work for Mr. Eckart and he went into it heartily and with all his accumulated experience and great ability for accurate work. Nearly two years were spent in collecting data, testing pumps and hoisting machinery, and in making drawings for the government of all machinery on the Comstock lode. The best

instruments procurable in the United States and Europe were used in the various investigations of efficiency. Hydraulic indicators testing from 500 to 3,500 pounds per square inch, made by Elliott Bros., of London, were used in the hydraulic pumps. Chronographs to measure and record the velocities of engines and pump rods, accurate to the one-five-hundredth part of a second, were used on the surface and at a depth of 2,300 feet below ground. By the use of this latter instrument, Mr. Eckart was able to throw light on some problems that had troubled many of us not a little. Diagrams taken from the heavy rods and pumps on the lower levels gave the clue to causes that had been so destructive in the breaking of so many rods and balance bobs in the past. The velocity curves of the pumps and rods revealed the fact not heretofore known (and

While Mr. Eckart had no part in the designing or installing of the large hydraulic pumps already referred to, his investigations of their efficiency afterward added much knowledge on the problems involved in dealing with large bodies of water under high pressure, and a short statement in regard to this work can properly be given in a sketch of his life and work.

In 1880 and 1881 the writer of this sketch designed, and the Risden Iron Works built, installed, and set in operation at the 2,400-foot level of the combination shaft, a hydraulic pump operated from a surface hydraulic pump engine pumping into a surface accumulator which was a huge air vessel 42 inches diameter and 80 feet high, in which from 900 to 1,000 pounds pressure per square inch was maintained. This


Tank
MEXICAN UNION SHAFT
C.N.S SHAFT
Surface Pipe Line
YELLOW JACKET SHAFT
OPHIR M.C. SHAFT
Level of Surface Engines
SKETCH DIAGRAM
SHOWING LOCATION OF PUMPS RELATIVE TO THE SUTRO TUNNEL AND PRESENT WATER-LEVEL IN THE MINE.
2016.5 Feet-Head of Water for Power
Sutro Dis. 1880
Sutro Dis. 1881
Sutro Tunnel
Die Pipe
Hydraulic Discharge
Sutro Tunnel
Sutro Discharge
Discharge Pipe
Sutro Tunnel Level
Water Level
Water Level 1893
Jan. 30 Water
March Water
Stood 1720 1870 Approximate
1742 1893
Jan. 12 1879
Started 3rd Pump
Nov. 8 1879
Started 4th Pump
Started Mar. 1881
Hydraulic
Started Jan. 1884
Hydraulic
Started Aug. 12, 1882
Started June 28, 1884
Started Jan. 17, 1888
Hydraulic
Started Feb. 6 1886
End of Pump Rod
3155 End of Pump-rod
1st Start of Pump to Surface, July 3, 1880
2nd " " " Sutro Tunnel
14 Pumps up to January 17, 1883
From Feb. 15 to End
Note: The Workings of this Mine extended to the 3300 Level but all Water was raised to Sump by Donkey Pumps run by Compressed Air
This Drawing gives the Dates of Starting Pumps etc. also Distances to Pump Stations
243 Feet
Machinery, N.Y.

Cross-section through Shafts on the Comstock Lode, showing long Pump Rods, Balance Bobs, and Pumps.

only in later years properly understood) that the elasticity of long rods could give rise to free vibrations and accelerations due to the engines and pumps. Maximum vibrations and strains resulted at certain parts of the rods which exceeded the elastic limit of the timber of which the rods were constructed. Proper changes in the location of the balance bobs and their weights increased the efficiency of the pumps and checked the destruction of rods and bobs. Some of these velocity diagrams, as well as illustrations of the largest pump engines and hydraulic pumps, were published by Prof. A. Riedler of Berlin while acting as commissioner to the German government in 1893, "*Maschinenarbeit und Ausnutzung der Natur krafte in Amerika*," Vol. II.

gave a working pressure on the pipes and pumps at the 2,400-foot station equal to 4,700 feet head. The pumped or mine water was elevated 802 feet to the Sutro Tunnel, while the power water was returned to the surface pumps 2,400 feet above, where it was again pumped into the accumulator, to be used over as power water. A description of this installation was published by Mr. Joseph Moore in "*The Transactions of the Institution of Engineers and Shipbuilders in Scotland*," 1881 and 1882.

Soon after starting, power water was obtained from the pipe lines of the Virginia City Water Power Company and the large surface engines were discontinued. The underground pumps were then run as hydraulic engines, and both mine

and power water were discharged into the Sutro Tunnel. In 1884 and 1885 additional pumps were put in on the 2,600 and 3,000-foot levels. At the lower pump the power water was received and operated, the pump under 3,440 feet head discharging the mine water under 1,420 feet lift.

All of this engineering was of a pioneer type as no similar conditions were known. Responsibility for the entire success of the installation was assumed and guaranteed by the builders and their engineers. Many hitherto unknown difficulties due to the excessive pressures, hot water, and the vapors generated from same, were encountered at the start. The writer's hair became gray in three months in the struggle but the difficulties were successfully met and overcome by persistent, painstaking, arduous work. The high altitude of the Comstock mines—the boiling temperature of these being but 202 degrees, added to the troubles from hot water. Several men lost their lives while working around the pumps. An extract from a newspaper of December 4, 1881, says: "Thomas Grant and Thomas Matthews were very severely scalded at the Chollar-Norcross-Savage Shaft. It appears that they were about to change a clack in the hydraulic pumps at the 2,400 level, and in taking off the door of the clack chamber were overwhelmed with a flood of hot water. Mr. Grant received the water across the arms, and though his injuries are very severe, will recover in due time. Mr. Matthews, however, was struck about the neck and the hot water poured down over his whole body and he died Sunday morning." It will be seen from this sad notice that the water had already passed through the pumps and still retained this scalding temperature even when in the discharge columns. The writer knows from his own experience how a drop of water from the roof of this station would raise a blister in the skin. The pump stations and drifts, although supplied with air from enormous fans, had an average temperature of about 96 degrees and were nearly saturated with moisture. Ice in large quantities had to be supplied underground, and cooling stations for miners, had to be erected before drifts could be run. It was under these conditions that Mr. Eckart carried on his experiments, gathering accurate data in locations where existence was a problem that had first to be solved. Then the other difficulties, the hot water and air, for instance, were taken advantage of to a certain extent by the engineers, and compound pumps and underground hoisting engines were designed to utilize the hot water and air of the mines in re-heating the compressed air used in the cylinders for pumping and hoisting, thus greatly increasing the efficiency of all underground machinery over what had been accomplished elsewhere.

Deep mining began to decline about 1880 and Mr. Eckart removed to San Francisco, opening an office as a consulting and constructing engineer. During the following ten years some of the largest and most important mining plants were designed and constructed under his supervision. A notable example is the pumping engine for the Ontario Mine with perhaps the largest Cornish pumps for deep mining ever built in the United States. The pumps were 20 inches diameter by 10 feet stroke, two pumps at each station and operated from one pump-rod 2,000 feet long. (An illustrated description of this machinery will be found in *Engineering News* for November 29, 1894.)

In 1881 Mr. Eckart began plans for all of the Anaconda Copper Works, hoists and reduction work for Haggin & Tevis, and for the following seven years as engineer for that firm all of their mining and mills were planned in his office. The Anaconda Reduction Works in Montana, started as a silver mill, with a capacity of less than 350 tons per day, and increased in size until in 1888 3,000 tons per day could be worked. He also designed and built for the same firm the "Giddes and Bertrand" mill in Nevada, the "Sheep Ranch," "Fine Gold," and "Kentuck" mills of California, the "New Ontario" and "Daly" mills of Utah, the "Guanacevi" and "Jocustitao" mills of Mexico, beside work for other firms during the years between 1880 and 1900. Mr. Eckart designed and built the "Quijotoa" and "Mt. Cory" mills for J. C. Flood, the "Cibolo" mill for Boyd and Cook, the "Lexington" mill and hoists at Butte, Montana, "Minas Prietas" and "Sombrerete" in Mexico. The latter works had two shafts over 1,000 feet deep, and had been filled with water and on that account not worked for over one hundred years, but the water was pumped out and large hoisting works and a chloridizing mill were erected. This was before railroads to that section of Mexico were completed.

When the Union Iron Works began building warships for the U. S. Government, Mr. Eckart, who had always kept in close touch with these works, was appointed consulting engineer and the management often sought his advice on engineering problems connected with the building of these vessels. He was present at and assisted in conducting most of the preliminary and official trial trips and reported on the efficiency of the machinery as shown by the data collected.

In 1896 Mr. Eckart succeeded in getting the water out of the Allison Ranch Mine at Grass Valley, California. Some thirty years before that date water broke into the lower level and drove the miners out and for all those years the mine lay idle and resisted all attempts to drain it. He was also engineer for the Comstock Pump Association from 1890 to 1892 and remodeled the wire rope transmission at the C and C shaft and further examined and made changes in the electrical transmission at the Chollar Mill, Virginia City, from 1888 to 1892. In 1899 Mr. Eckart was appointed consulting engineer to the Standard Electric Co. and afterward became the resident constructing engineer for all of their hydraulic works, including storage-reservoir, ditches, dams, flumes, pipe lines, and power house installation. This was among the first long-distance, high-potential, hydraulic transmission plants projected. The water was to be brought from the "Blue Lakes," situated some 9,000 feet above sea level. The power water for wheels was under 1,400 feet head, and was to develop 15,000 horsepower. This work was successfully completed in 1903. It is odd to find this veteran engineer controlling and using the "ice-cold waters of the Sierras" thousands of feet above sea level and some twenty-five years after his experience in handling and forcing to the surface, from 3,000 feet below the surface, the hot water of the "Comstock Mines."

As to the personality of Mr. Eckart it is pretty closely written all over the engineering development of the Pacific coast. This is what he says of himself: "Whatever success I have achieved in a rather strenuous engineering life covering forty-five years of practice on the Pacific coast has been in a great measure due to a studious life surrounded by an extensive, carefully-collected, engineering library of American and foreign books and the appreciated assistance of associated engineers, together with the encouragement and loyalty of employers."

Mr. Eckart's life has been entirely devoted to his profession perhaps to too great an extent. Only those, among whom the writer is proud to be numbered, who have been associated with him for years, can estimate in any sense the worth of his services to the engineering profession. It is difficult to give any true impression of such a life in such a brief sketch. When the history of engineering on the Pacific coast comes to be written, it will not be complete unless the work of W. R. Eckart occupies the large place in the book that it occupies in fact, and in the experience of his contemporaries.

Mr. Eckart has been honored by membership in the following societies:

American Society of Civil Engineers since 1881.

American Society of Mechanical Engineers since 1882—Vice-President 1883-1885.

The Institution of Mechanical Engineers, London, 1878.

Society of Naval Architects and Marine Engineers, 1893.

American Society of Naval Engineers.

Associate Member The Institution of Naval Architects, London.

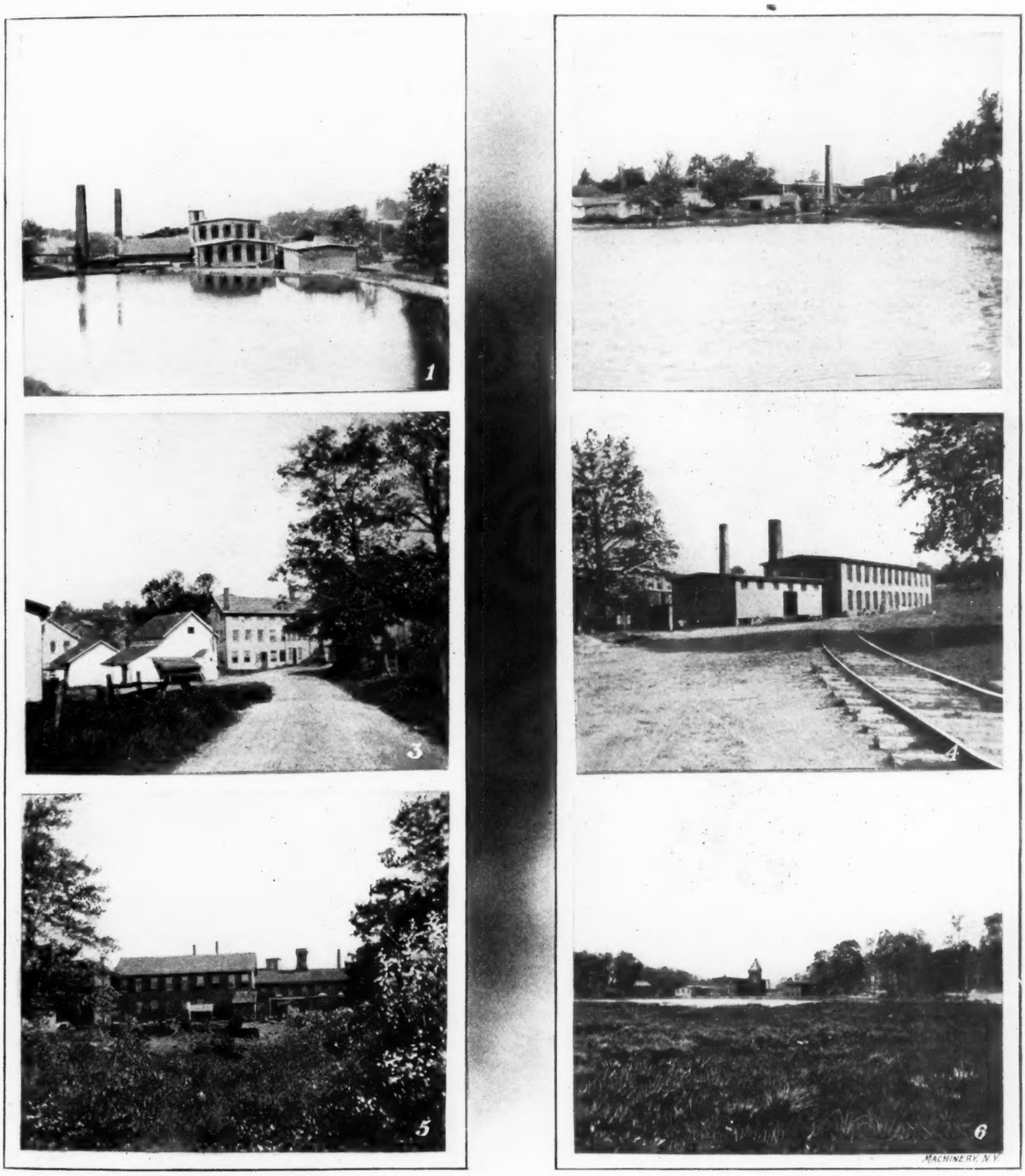
* * *

The severe requirements imposed upon automobile gearing have caused some manufacturers to make the teeth of modified form, using 20-degree involute teeth of about three-fourths the height of a standard tooth. For example, 6—8 pitch is considerably used, the dedendum and addendum circles being spaced ⅛ inch from the pitch line instead of 1-6 inch, as would be the case in a standard gear. In this nomenclature, the second figure gives the spacing of the addendum and dedendum circles, and the first the diametral pitch.

THE BELL INDUSTRY.

STORRS ELY EMMONS.

It is not generally known that the bulk of the bells used in the countries of the world are made in the United States, and that about three quarters of these tinklers come from East Hampton, Conn. The factories of this town may be considered the nucleus of the bell industry, and they have a world-wide reputation for both quantity and quality of output.



1.—Summit Thread Co.
2.—Bevin Bros. Mfg. Co.
3.—East Hampton Bell Co.
4.—Silk Mill.
5.—Starr Bros. Bell Co.
6.—Hill Brass Co.

Every conceivable kind of bell is manufactured here, from church to cow bells, and bell toys. The goods are shipped to every country on the Globe. India uses them on her temples; Switzerland orders for her herds, and Prussia for her sleighs.

The industry is of nearly a hundred years standing, having been established in 1808 by Wm. Barton. Prior to this date he was engaged in the manufacture of andirons and brass goods in New York City. It was while there that he became acquainted with a mechanic who suggested the manufacture of sleigh-bells. At this time these were all imported from Europe. The idea was acted upon, and the first plant, small, and crude, was started in East Hampton.

Improvements were soon introduced in manufacturing methods, one of them being to cast sleigh-bells in one piece. This was an innovation, for they were all formerly made in halves in order that the jingle could be inserted, and then either riveted or soldered together. By the new method the jingle was embedded in the sand, forming the core. After the bell was cast the sand was cleaned off, the jingle remaining inside. Barton also lessened the cost of producing church, and hand bells by finishing them on a lathe. Previous to this the work had all been accomplished by hand. The industry thus gained a prestige which it never lost.

In 1827 Wm. Barton's sons, Hiram and Hubbard, took the

business. Jason, another son, was for a time with the business. He invented the tumbling barrel for finishing bells, now well known, and much improved.

Since that time there have been many changes, both in the mode of manufacture, and in the firms engaged. The power was all by hand at first, but as the business increased it became necessary to utilize the water which flowed in great abundance from Lake Pocatopgue.

Eight firms were engaged in the bell business in East Hampton a number of years ago, but at the present time there are but five. This does not mean that the industry is on the decline, but rather that there has been a consolidation of several of the smaller firms. The present concerns are, Bevin Bros. Mfg. Co., Inc., founded in 1838; East Hampton Bell Co., founded in 1851; Gong Bell Mfg. Co., founded in 1866. The Starr Bros. Bell Co., and the H. H. Hill Brass Co. are of more recent origin.

The East Hampton Bell Co., and the Gong Bell Mfg. Co., are run in conjunction. These two firms, and the H. H. Hill Brass Co. are in the corporation. While the bulk of the work turned out by these three plants is bells, still a considerable number of bell toys are placed on the market, making one of the chief competitors of German importations.

The H. H. Hill Brass Co. make a specialty of struck-up bells, while the Gong Bell Mfg. Co., and the East Hampton Bell Co. are noted for their high-grade cast and turned varieties, such as are used in chimes, musical instruments, etc. An example of a large gong turned out by these people is to be found in the New York Stock Exchange, being 28 inches in diameter.

Bevin Bros. Mfg. Co. have the largest plant exclusively devoted to the manufacture of bells. They are the first on the stream which carries off the overflow from the lake. It stands in striking contrast as to machinery, and methods to Wm. Barton's original shop. Every possible appliance, consistent with a superior article, is used to diminish the cost of production.

The Starr Bros. Bell Co., while of a later birth, is doing a large business, and bids fair to hold up the reputation of the town. The plant is modern as to its appointments.

The village contains 2,300 to 2,500 people out of whom fully 25 per cent work in the bell shops. The balance of the working population is divided between one or two wagon works, a thread mill, a bolt cutting machine plant, and one or two other small ventures. The town is the manufacturing city in embryo.

The economic importance of the location of East Hampton partially explains why they are able to place their goods in all the markets of the world. In the first place the town lies in a rich agricultural district, high, well watered and drained. It is on the "Air Line" division of the N. Y., N. H. & H. R. R., about mid-way between New York, and Boston. A drive of three miles brings one to the river landing, making it possible to get good freight rates. The natural power of the place is of much importance.

The body of water supplying this power is nearly ten miles in circumference. Its average depth is ten feet, being fed by springs, and mountain brooks. The banks are rock-bound, and lead back on three sides to wooded slopes. The side toward the outlet of the lake is sandy and shelving. The bank at this point reaches its maximum height, about seven feet, some 400 feet from the shore line. Here the first fall of the stream is found. From this first drop to the place where the stream flows into Salmon River, a distance of about nine miles, the waters of the lake fall about 460 feet.

As with most such sources of power the water in the lake becomes low during a protracted dry spell. While the lake has never failed to yield sufficient energy (1,000 H. P.), still, owing to the increasing activity, it is now being considered advisable to put in a dam of sufficient size to raise the surface of the lake twelve inches, and it is understood that some rights have already been purchased for this purpose.

* * *

Don't forget that a mill file pushed diagonally across a shaft in the lathe will cut off a great deal more metal in the same time than it will if it is pushed square across.

MAKING A BLANKING DIE.

C. F. EMERSON.

From a mechanical standpoint it can truthfully be said that we are living in an age of dies. Never before has the industrial world made use of the punch and die as it is doing to-day. And no wonder; for this useful tool in all its different phases has proven beyond all reasonable doubt that it can turn out more work in less time than the combined efforts of a room full of milling machines, shapers and drill presses.

To those who are unfamiliar with the die and its work the above may not appear feasible; but one has only to visit a modern sheet metal factory to be convinced of the surprising rapidity with which the power press with its punches and dies will turn out not only accurate work, but work of all kinds of shapes and sizes.

Of the many different kinds of dies in use, the blanking die is probably the most widely used. The reason for this is that almost all work that requires the use of various other kinds of dies has its beginning with the blanking die; for it is this die that cuts the work from the flat stock before it is completed by the other dies.

In making the blanking die there are a few essential things to be taken into consideration, among which are the following:

1. Use good tool steel of a sufficient length, width, and thickness to enable the die to hold its own.

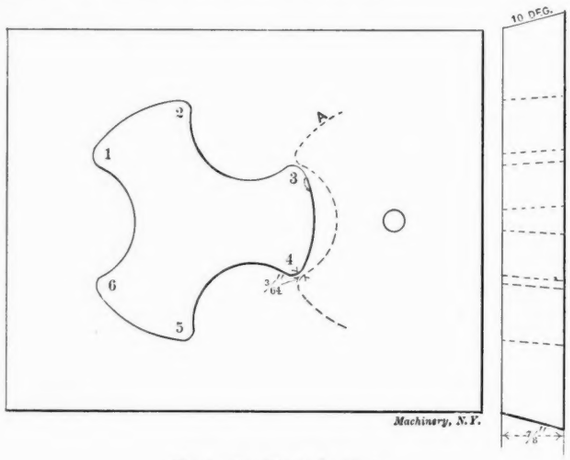


Fig. 1. The Die to be Made.

2. In laying out the die care should be taken that as little of the stock as possible is left over, as waste, in cutting out the blanks.

3. Be sure not only that the die has the proper amount of clearance (which should be no more than two degrees and no less than one degree); but also that the clearance is filed *straight*, so as to enable the blanks to readily drop through.

4. In working out the die, machine out as much as you can; don't let the file do it all.

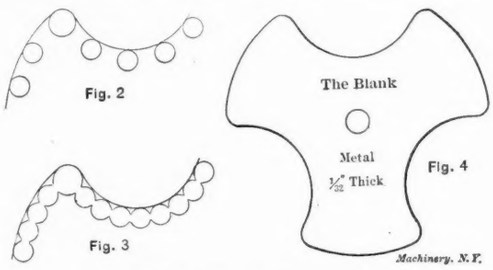
5. In hardening the die do not overheat the same, as the cutting edge of a die that has been overheated will not stand up to the work, and requires so much sharpening in order to produce perfect blanks, that at its best it is nothing more than a nuisance.

In laying out the blanking die the face of the die is first polished smooth and drawn to a blue color by heating. This gives better satisfaction by far than using coloring acid, for it gives a clear white line on a dark surface to work to and is easier on the eyes, particularly when working by artificial light as is often necessary. When the die to be laid out is a blanking and piercing die, allowance of 3-64 inch must be made for the "bridge," *i. e.*, the narrow strip of metal that separates the holes in the stock from which blanks have already been cut. Fig. 1 shows how this is done; the dotted line *A* is drawn merely to show how the die is laid out.

After the die is laid out it is ready to be worked out. Now there are several different ways of working out the surplus stock in a die of this kind. One is to drill say a half-inch

hole at a safe distance from the line and then fasten the die in a diemaker's milling machine and mill the stock out close to the line with a taper milling cutter, which gives the die the necessary clearance, thereby saving considerable time when filing out the die.

Another method, which is most commonly used, is to drill out the surplus stock on a drill press, after the manner shown in Figs. 2 and 3, which is done as follows: The six holes for the corners numbered 1, 2, 3, 4, 5, 6, Fig. 1, are first drilled and reamed taper, after which the other holes are drilled. These holes are drilled an even distance apart, and must therefore be spaced off, and then spotted with a prick



Methods of Outlining the Blanking Die.

punch before they are drilled. The best way to do this is to first scribe an inside line at a distance from the outside line equal to one-half the diameter of the holes to be drilled, then space off, and spot. In spacing off don't use your dividers, use a double prick punch. Using a pair of dividers takes up too much time, besides the points get dull quickly enough without using them when it is unnecessary. After the line has been lightly spotted with the double prick punch, use an ordinary prick punch and make the spots a trifle deeper so that the drill will more easily take hold.

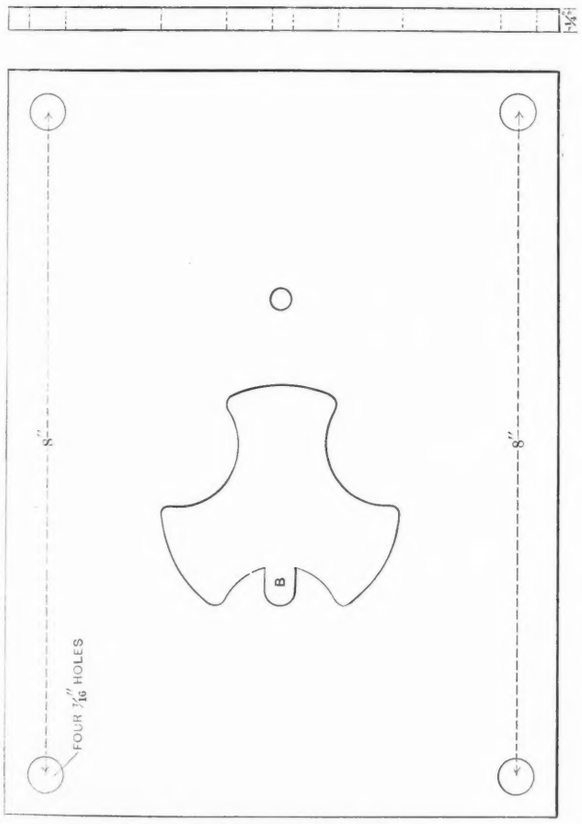


Fig. 4. The Stripper Plate.

In drilling, use the method shown in Figs. 2 and 3, for in this way the holes can be drilled closer together, thereby making it easier to get rid of the surplus stock and saving the time of broaching out the webs. The die blank should be slightly tipped by placing a narrow strip of flat stock under the edge of same, as shown in Fig. 6, when the die is being drilled. This is done to give the necessary clearance, and does away with that time-killing operation of reaming the holes with a taper reamer from the back after they are drilled. After the surplus stock is gotten rid of the die is finished up by filing, using a coarse file to begin with and finishing with a smooth one.

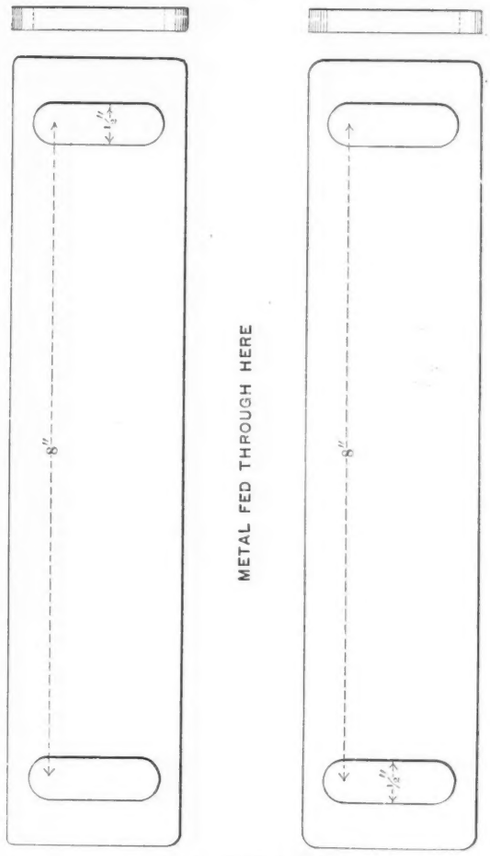


Fig. 5. The Gage Plates.

Usually the die is made to fit a sample blank or a template. This is done by entering the template from the back as far as it will go after the die has been filed to the inside of the line. A lead pencil is then used to mark that part of the die where the template bears. The template is then removed, the pencil marks filed out, the template again entered and so on until it is worked through the die.

In filing out a die of this kind where there is any danger of filing out that part of the die which has already been

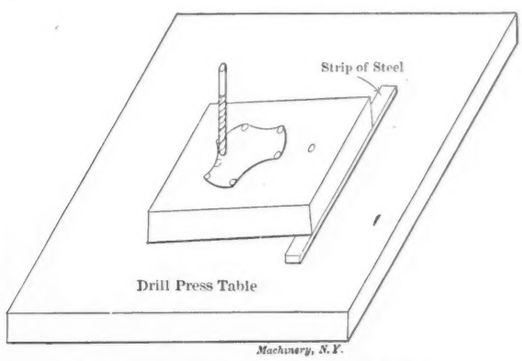


Fig. 6. Giving Clearance to the Drill Holes.

finished, use two strips of sheet steel, *A* and *B*, in the manner shown in Fig. 7, the round corners which are already finished being protected from the edges of the file.

In hardening the die heat the same, preferably in a gas furnace or a clean charcoal fire, to a cherry red and dip endwise into the solution used for hardening. When the die is sufficiently cold so that it can be taken hold of by the hands withdraw quickly and place on the fire until it has become

so warm that it will make water sizzle when dropped thereon; then immerse once more until cold. This is done to relieve the internal strains caused by hardening, and acts as a preventive to cracking.

The face of the die is now polished and the temper drawn to a light straw color, after which the die is allowed to cool of its own accord in oil. When cool the die is ground on a surface grinder on the top and bottom and if it is required it is lapped to size, which completes the operations.

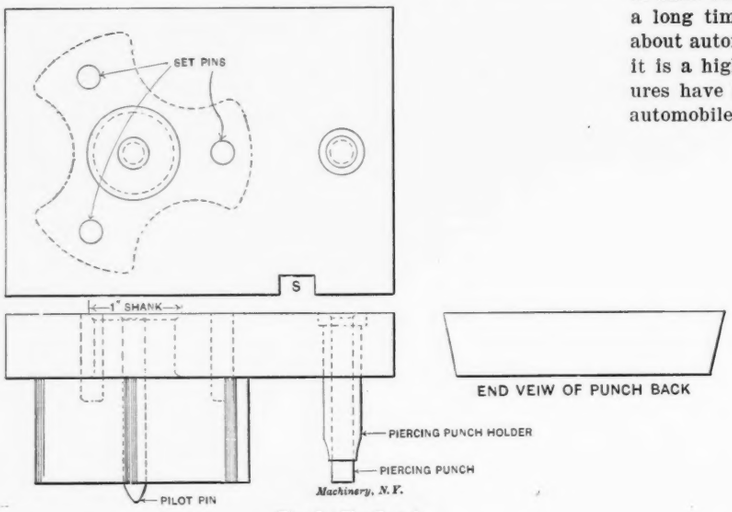


Fig. 8. The Punch.

The punch is made after the manner shown in Fig. 8, and needs very little explanation. The dovetail punch back shown holds the punches in position and is securely held in the press by the aid of a key. The slot *S* forms a position stop by engaging in a stud in the dovetail channel in the ram of the press, thereby eliminating the necessity of again resetting the tools in case the punch requires sharpening.

The blanking punch is made from a tool steel forging, and is machined and sheared through the die in the usual manner. The one-inch shank is made a good driving fit in the punch back and is upset as shown after the punch is driven in. The three set pins help to more securely hold the punch in position and prevent it from turning.

The piercing punch is held in position by the piercing punch holder which is driven tight in the punch back. The piercing punch is lightly driven in and is made of drill rod and can be very readily replaced in case it is broken. The pilot pin is also made of drill rod and can be very easily and quickly taken out when the punch requires sharpening.

The stripper and gage plates for this die are shown in Figs. 4 and 5. They are fastened by 4 7-16 cap screws to the die bed, used for holding the die in position when in use, and form, in the writer's opinion, not only the best, but by far the cheapest of the various methods he has come in contact with. While this method cannot be used on all kinds of blanking dies, it can, however, be used with the best of results on dies similar to the above and does away with the unnecessary operation of drilling and tapping holes in the die itself to hold the stripper and gage plates in position. Not only that, but the gage plates as shown are used in connection with many other dies of a similar nature, thereby doing away with the necessity of having a set of gage plates for every die, as is the case in some shops.

As the sketches speak for themselves, no more explanation seems necessary except perhaps that the slot *B* shown in Fig. 4 is to allow for an automatic finger to act as a position stop for the metal when it is run through.

* * *

Professor Pierre Curie, the famous discoverer of radium, was run over by a wagon in the streets of Paris, France, and killed April 19, 1906. Prof. Curie was about 57 years old, and began his scientific research work before leaving school. He was greatly assisted in his researches by his wife, Madame Curie, and it is really to her that the greater part of the honor of the discovery of radium is said to be due.

COST OF AUTOMOBILE OPERATION.

It requires an optimistic mind to think of the automobile truck supplanting the horse-drawn truck or any form of the motor-driven vehicle competing successfully with the horse at present, except where the cost of operation is a secondary consideration. The price of gasoline makes the fuel account a costly item, and this with the repairs for tires and periodical overhauling of the machinery, together with the unreliability of such vehicles, seems to indicate that their universal use is a long time in the future. Every one who knows anything about automobiling for pleasure, knows, in a general way, that it is a highly expensive sport, but very few authoritative figures have been published, giving the individual experience of automobile users. The May issue of *Country Life in America*

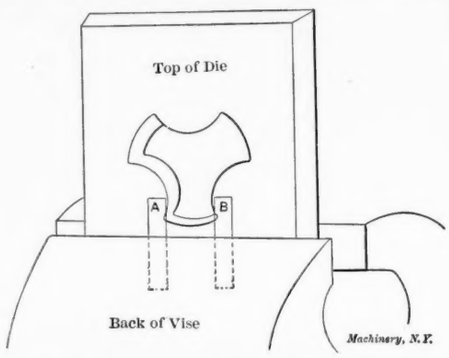


Fig. 7. Guarding the Corners in Filing the Die.

contains an article in which the author opens his heart and account book and tells the reader something of what they may expect to happen to their pocketbooks in case they buy a touring car costing, say, about $2,500 and seating six people. His purchase was a 20-horse-power double-cylinder machine, weighing about 3,000 pounds and costing $2,630 with certain extras. The cost of operation and depreciation are given in the following, from which it appears that for ten months' use the total expense was $1,473.76, or an average monthly expense of $147.37. During this period of ten months the car covered an approximate distance of 8,000 miles, and is claimed to have carried an average of six passengers. On the basis of 48,000 passenger miles, this figures out 3.07 cents per mile per passenger, or more than the average local railroad fare in the Eastern States. It will be observed that the most favorable condition is assumed in that the car was carrying an average of six passengers all the time, whereas in most cases the average number of occupants would probably not have been more than three, thus doubling the cost per passenger mile, and with no appreciable reduction in the cost of operation. The owner was fortunate in not having any serious breakdowns or smashups such as befall a considerable number of the automobiling fraternity.

First cost of machine	$2,600.00
Interest on investment at 6 per cent (ten months)	130.00
Twenty-five per cent depreciation for use (making present high market value $1,950)	650.00
Gasoline	120.15
Lubricating oils, greases, etc.	18.25
Mechanics' time overhauling, repairing and adjusting	89.78
Cost of new parts bought	58.30
Insurance expense	95.00
Tire expense	176.88
Storage expense	123.00
Batteries	6.00
Carbide for lamps	6.40
Total	$1,473.76
Average monthly expense	147.37

In the above it will be noted that a depreciation of 25 per cent is marked off for the ten months' use, and this, of course, makes the monthly operation cost high. But this depreciation is none too liberal for a pleasure car, although it would probably be somewhat excessive for a purely commercial vehicle.

* * *

Don't run a polishing wheel on brass for any length of time without wearing a wet sponge over your mouth and nostrils.

A NEW FORMING LATHE.

We are indebted to our contributor, Mr. James Vose, Manchester, England, for particulars regarding a forming lathe built under Siebert's patents by John Holroyd & Co., Ltd., Milnrow, Manchester, England, which is shown in the illustrations, Figs. 1 and 2. The interesting feature of this lathe is a forming arrangement designed in this particular instance for the rapid production of duplicate test pieces of tire steel, etc., though this feature is applicable to many other uses, such as automatic forming in connection with forming lathes for all varieties of work, even for work as large as railroad axles.

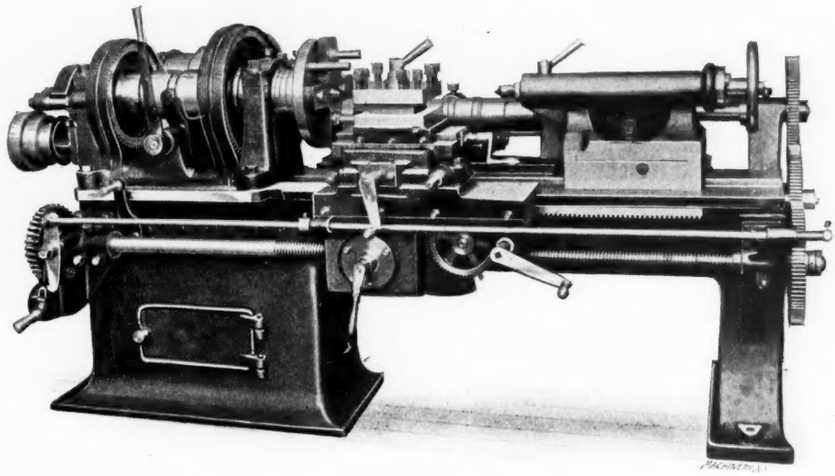


Fig. 1. Front View of Forming Lathe built by John Holroyd & Co.

The headstock carries a steel spindle running in parallel gun-metal bearings. The cone pulley is carried on a rear spindle and drives the main spindle of the lathe through either of two sets of gears, one driving the lathe at twice the speed of the other. The change from one speed to the other is rapidly made by means of a handle conveniently placed in front, which shifts a positive clutch on the main spindle.

The lathe carriage is fitted with a compound slide and square steel turret for holding tools. It has a hand movement by rack and pinion and a power traverse movement by the guide screw and a double clamp nut. The guide screw receives its motion through a worm and worm wheel and a train of gears driven by a belt and the small cones at the headstock end of the lathe. Six changes of feed are secured through the three steps of the feed cones and a two-speed gear box, the feed being disengaged automatically at any desired point by tripping a drop worm box. At the rear of the lathe is a scroll-type former carried on a splined shaft driven through gearing at the same speed as the guide screw. The scroll is mounted between two sliding uprights that are given a traverse motion on the auxiliary ways at the rear of the lathe by means of a screw operated by the feed gearing. The traverse motion of the scroll is in a direction opposite to the longitudinal travel of the lathe saddle. It will thus be seen that the shape of the piece being formed is governed both by the shape of the scroll and the distance traveled by the scroll in a given time, relative to the travel of the cutting tool. The length of the scroll thus may be varied in any desirable proportion to the length of the object being formed, making it possible to secure abrupt changes of contour in the piece being formed without having corresponding abrupt changes in contour of the scroll. There is thus small tendency to bind the cross slide, owing to side thrust upon the roller which bears against the scroll.

In the lathe illustrated, the arrangement of speeds and feeds and the locking arrangements of the cross slide allow the operator to take a heavy cut over the work in the usual manner; then, after changing the speeds and feeds, he unlocks the cross slide, allowing it to be controlled by the roll bearing against the scroll and takes the forming cut. In Fig. 3 are photographs of four scrolls of different shaped pieces of work and one test bar that has been turned up is also shown. The surfaces of the scrolls form what is really a continuous path from end to end, increasing or diminishing in diameter as required. The scroll is cut to the required shape in position by a small milling head, using an end mill, which is supplied in addition to the usual lathe accessories. This mill cuts a flat spiral path which the flat roll attached to the cross slide follows. For the particular duty for which the lathe illustrated was designed, one scroll only is required and a weight is employed to hold the forming slide against the scroll when the cutting tool is idle. When the cutting tool is in progress the tendency to keep the slide in contact with the scroll is increased by the pressure against the tool. On some heavy classes of work the weighting is omitted; two forming scrolls located inversely to each other control a bowl, carried on a prolongation of the forming slide.

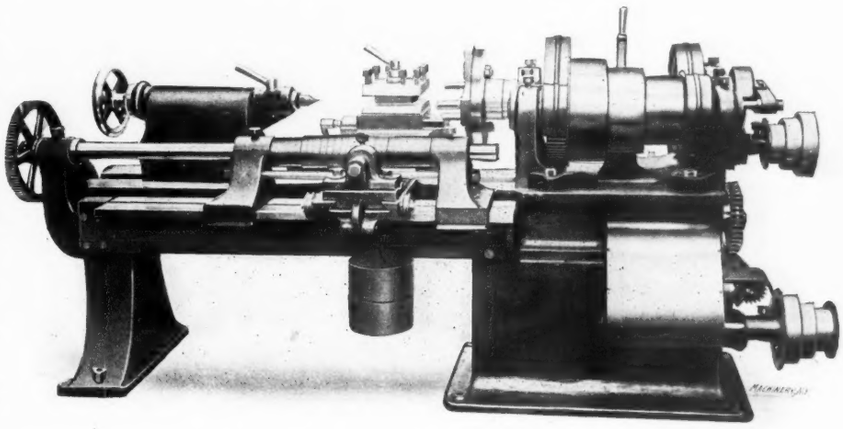


Fig. 2. Rear View of Lathe, showing Forming Cam.

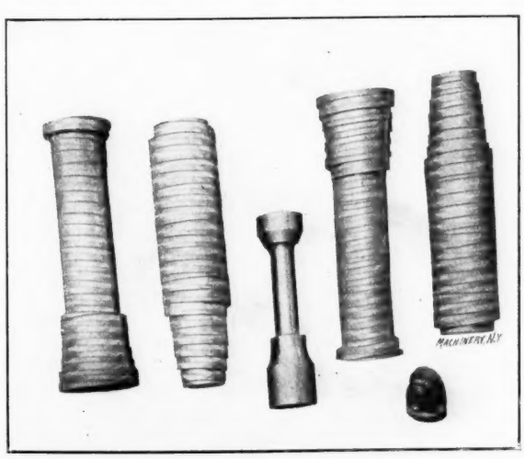


Fig. 3. Forming Cams and Sample of Work.

* * *

Don't forget that a lathe may be made to bore larger or smaller at one end or the other by setting the tool above, or below, or exactly on the center.

PROPOSED STANDARDS FOR MACHINE SCREWS.

A committee appointed by the American Society of Mechanical Engineers to investigate the subject of machine screw proportions and to recommend standard specifications for machine screws, made its first report at the last annual meeting. A second, and what was intended to be a final report of the committee, was presented at the Chattanooga meeting; but in the discussion which followed there were various and widely divergent criticisms of the report. The committee was therefore continued and will again report at the next annual meeting. The work of the committee has advanced to such a point, however, that the following abstract of the report will be of interest, but it should be borne in mind that this is subject to revision and is not final. The diameters and pitches, with the method recommended for establishing and maintaining them, are given herewith, together with proportions for machine screw heads. Considerable attention was given in the report to the question of size limits, but space will not be taken in this abstract to cover this part of the question.

TABLE I. STANDARD MACHINE SCREWS.
(Thread U. S. Form.)

Standard Diameter.	Number of Threads per Inch.
0.070 in.	72
0.085	64
0.100	56
0.110	48
0.125	44
0.140	40
0.165	36
0.190	32
0.215	28
0.240	24
0.250	24
0.270	22
0.320	20
0.375	16

Form of Thread.—The Sellers, or U. S. form of thread, having an included angle of 60 degrees, and a truncation or flat at the top and bottom of the thread equal to one-eighth of the pitch of the thread, shall be used for the basic standards.

The form of thread for machine screws shall have an included angle of 60 degrees, a truncation or flat at the top of the thread equal to one-eighth of the pitch, and a truncation at the bottom of the thread equal to one-sixteenth of the pitch.

TABLE II. STANDARD REFERENCE THREAD GAUGES.

Standard Gauges for Taps. U. S. Form, except at Top of Thread, which is flat 1/8 Pitch.				Basic Standard. Reference Thread Gauges, U. S. Form.				Standard Gauges for Screws. U. S. Form, except 1/8 flat at Root.	
Diam. at Top of Thread.	Diameter at Root of Thread.	Pitch Diameter.	Excess Pitch Diameter over Basic.	Diameter Top of Thread.	No. Threads per inch.	Diameter Root of Thread.	Pitch Diameter.	Diameter Top of Thread.	Diameter at Root of Thread.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
.07209	.05255	.06157	.00059	0.070	72	.05196	.06098	0.070	.05046
.08732	.06533	.07548	.00063	0.085	64	.06470	.07485	0.085	.06301
.10260	.07747	.08907	.00067	0.100	56	.07680	.08840	0.100	.07487
.11298	.08366	.09719	.00072	0.110	48	.08294	.09647	0.110	.08068
.12821	.09623	.11099	.00075	0.125	44	.09548	.11024	0.125	.09302
.14350	.10831	.12455	.00079	0.140	40	.10752	.12376	0.140	.10482
.16884	.12975	.14779	.00083	0.165	36	.12892	.14696	0.165	.12591
.19427	.15029	.17058	.00088	0.190	32	.14941	.16970	0.190	.14603
.21981	.16955	.19275	.00094	0.215	28	.16861	.19180	0.215	.16474
.24553	.18689	.21396	.00102	0.240	24	.18587	.21294	0.240	.18136
.25553	.19689	.22396	.00102	0.250	24	.19587	.22294	0.250	.19136
.27599	.21202	.24155	.00107	0.270	22	.21095	.24048	0.270	.20603
.32653	.25617	.28864	.00111	0.320	20	.25505	.28753	0.320	.24964
.38302	.29506	.33566	.00125	0.375	16	.29381	.33441	0.375	.28704

NOTE.—Diameter at root of thread, for basic standard gauges,

$$= \text{standard diameter} - \frac{1.2990381}{\text{No. of threads per inch}}$$

Diameter at root of thread for standard gauges for screws = basic root diameter $- P(0.10825)$.

Diameter at top of thread, standard gauges for taps = standard diameter $+ \sqrt{P \times 0.005} + P(0.10825)$.

The form of thread for machine screw taps shall have an included angle of 60 degrees, a truncation or flat at the top of the thread equal to one-sixteenth of the pitch, and a truncation or flat at the bottom of the thread equal to one-eighth of the pitch.

Diameters and Number of Threads per Inch.—The list of screws adopted consists of 14 sizes having outside diameters and numbers of threads per inch as per Table I.

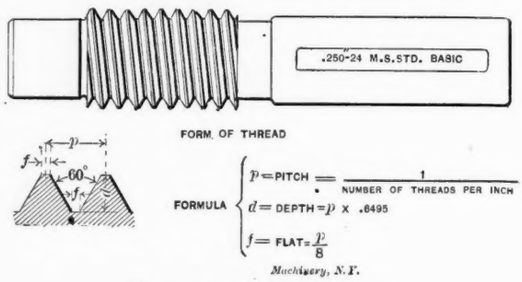


Fig. 1. Reference Thread Gauge

Standard Reference Thread Gauges.—As stated in the paper by Mr. Chas. C. Tyler (pages 608-9, Vol. XXIII., *Transactions* A. S. M. E.), in order "To secure the interchangeability of machine screws and taps, a practical system of gauging should be provided, and ultimate standards of reference are desirable, particularly in cases of disputed thread sizes. The modifications of the form of thread for screws and taps to give clearance, each being based on the United States standard

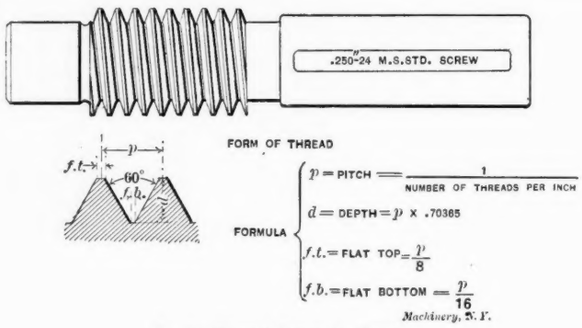


Fig. 2. Thread Gauge for Screws.

thread, make it seem desirable to provide three sets of standard reference thread gauges for each gauge diameter; one basic, one for screws, and one for taps."

The thread dimensions of these standard reference thread gauges are given in Table II.

The pitch diameters, given in the eighth column of Table II., are the diameters when measured in the angle of the thread, at points equi-distant from the top and bottom of the threads of the basic standards.

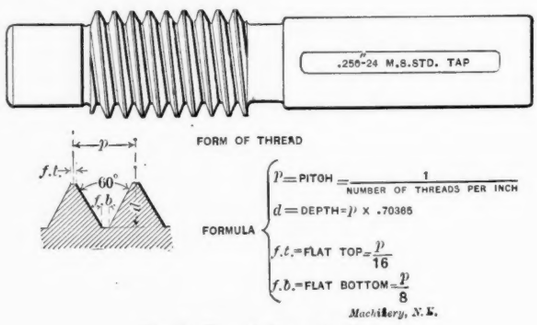


Fig. 3. Thread Gauge for Taps.

Basic Standard Reference Thread Gauges.—Following further the text of Mr. Tyler's paper, referred to, with slight modifications, your committee recommends as the foundation of the system, a set of basic standard reference thread gauges, these gauges to be made of unhardened steel, of 0.35 per cent to 0.40 per cent carbon, to represent exactly, in every detail, the U. S. form of thread, the diameter at the top of the thread, the diameter at the bottom of the thread, and the correct pitch; the included angle of 60 degrees, and the flat at top and bot-

tom of the thread equal to one-eighth of the pitch. Each basic standard gauge to have plainly marked thereon the diameter, number of threads per inch and "M. S. Standard Basic" (machine screw standard), as shown in Fig. 1, herewith. The basic standards to be used only for comparative calibration, in the making of the reference standard plug thread gauges for screws and taps. (See colums 5, 6, 7 and 8, Table II.)

Standard Reference Thread Gauges for Screws.—These gauges are to be made also of unhardened steel, 0.35 per cent to 0.40 per cent carbon, to represent exactly, in every detail, a screw having the modified U. S. form, *i. e.*, a flat at top of one-eighth of the pitch, and at bottom of one-sixteenth of the pitch, with an included angle of 60 degrees, the exact diameter at the top and at the bottom of the thread, and the correct number of threads per inch. Each standard gauge for screws to have plainly marked thereon the diameter, number of threads per inch, and "M. S. Standard Screw," as shown in Fig. 2.

The gauges for screws should be exact duplicates of the basic standards, in external diameter, pitch and number of threads per inch, also in pitch diameter, measured in the angle of the thread, but to be less in diameter at the bottom of the thread, corresponding to the decreased width of flat, which at this point is one-sixteenth of the pitch. These decreased root diameters are given in column 10, Table II.

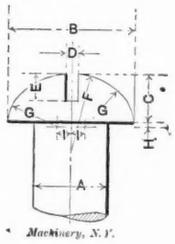
All details for measurement, for basic and reference thread gauges for screws, are given in Table II., excepting only those for width of flat.

Standard Reference Thread Gauges for Taps.—These gauges are also to be made of steel, 0.35 per cent to 0.40 per cent carbon, unhardened, to exactly represent in every detail, the size of a threaded tap before being fluted, having the included angle 60 degrees, the flat at top one-sixteenth of the pitch, with flat at bottom of the thread equal to one-eighth of the pitch, and to correctly represent the standard pitch of thread. The external diameters to be as given in column 1, Table II.

The increased external diameters there given are due to allowance for flat of one-sixteenth of the pitch and for error of lead due to hardening, as already mentioned in a preceding paragraph.

TABLE III. ROUND HEAD MACHINE SCREWS.

A = Diameter of Body.
$B = 1.83A$ = Diameter of Head.
$C = 0.703A$ = Thickness of Head.
$D = 0.235A$ = Width of Slot.
$E = 0.40A$ = Depth of Slot.
$F = 1.095A$ = Rad. of Top of Head.
$G = 0.70A$ = Rad. of Sides of Head.
$H = 0.068A$ = Dist. from Bottom of Head to Center of G.
$I = 0.213A$ = Dist. from Center of Head to Center of G.

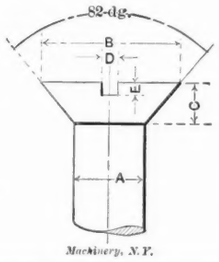


Machinery, N.Y.

A	B	C	D	E	F	G	H	I	Thr'ds per In.
.070	.1281	.0492	.0164	.0280	.0766	.0490	.0048	.0149	72
.085	.1555	.0597	.0200	.0340	.0931	.0595	.0058	.0181	64
.100	.1830	.0703	.0235	.0400	.1095	.0700	.0068	.0213	56
.110	.2013	.0773	.0258	.0440	.1204	.0770	.0075	.0234	48
.125	.2287	.0879	.0294	.0500	.1369	.0875	.0085	.0266	44
.140	.2562	.0984	.0329	.0560	.1533	.0980	.0095	.0298	40
.165	.3019	.1160	.0388	.0660	.1807	.1155	.0112	.0351	36
.190	.3477	.1336	.0446	.0760	.2080	.1330	.0129	.0405	32
.215	.3934	.1511	.0505	.0860	.2354	.1505	.0146	.0458	28
.240	.4392	.1687	.0564	.0960	.2628	.1680	.0163	.0511	24
.250	.4575	.1757	.0587	.1000	.2737	.1750	.0170	.0532	24
.270	.4944	.1898	.0634	.1080	.2956	.1890	.0184	.0575	22
.320	.5856	.2250	.0752	.1280	.3504	.2240	.0218	.0682	20
.375	.6862	.2636	.0881	.1500	.4106	.2625	.0255	.0799	16

TABLE IV. FLAT HEAD SCREWS.

A = Diameter of Body.
$B = 2A = 0.0052$ = Diameter of Head.
$C = \dfrac{A - 0.0052}{1.739}$ = Thickness of Head.
$D = 0.235A$ = Width of Slot.
$E = 1.3C = \dfrac{A - 0.0052}{5.217}$ = Depth of Slot.

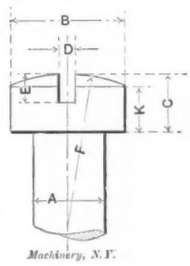


Machinery, N.Y.

A	B	C	D	E	Threads per In.
.070	.1348	.0373	.0164	.0124	72
.085	.1648	.0459	.0200	.0153	64
.100	.1948	.0545	.0235	.0182	56
.110	.2148	.0603	.0258	.0201	48
.125	.2448	.0689	.0294	.0229	44
.140	.2748	.0775	.0329	.0258	40
.165	.3248	.0919	.0388	.0306	36
.190	.3748	.1063	.0446	.0354	32
.215	.4248	.1206	.0505	.0402	28
.240	.4748	.1350	.0564	.0450	24
.250	.4948	.1408	.0587	.0469	24
.270	.5348	.1523	.0634	.0508	22
.320	.6348	.1816	.0752	.0605	20
.375	.7448	.2126	.0881	.0709	16

TABLE V. OVAL FILLISTER HEAD SCREWS.

A = Diameter of Body.
$B = 1.6A$ = Diameter of Head.
$C = 0.80A$ = Thickness of Head (oval).
$D = 0.235A$ = Width of Slot.
$E = 0.5C = 0.4A$ = Depth of Slot.
$F = 2.186A$ = Radius of Head.
$K = 0.65A$ = Thickness of Head (flat).

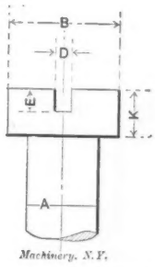


Machinery, N.Y.

A	B	C	D	E	F	K	Threads per In.
.070	.1120	.0560	.0164	.0280	.1530	.0455	72
.085	.1360	.0680	.0200	.0340	.1858	.0552	64
.100	.1600	.0800	.0235	.0400	.2186	.0650	56
.110	.1760	.0880	.0258	.0440	.2404	.0715	48
.125	.2000	.1000	.0294	.0500	.2732	.0812	44
.140	.2240	.1120	.0329	.0560	.3060	.0910	40
.165	.2640	.1320	.0388	.0660	.3607	.1072	36
.190	.3040	.1520	.0446	.0760	.4153	.1235	32
.215	.3440	.1720	.0505	.0860	.4700	.1397	28
.240	.3840	.1920	.0564	.0960	.5246	.1560	24
.250	.4000	.2000	.0587	.1000	.5465	.1625	24
.270	.4320	.2160	.0634	.1080	.5902	.1755	22
.320	.5120	.2560	.0752	.1280	.6995	.2080	20
.375	.6000	.3000	.0881	.1500	.8197	.2437	16

TABLE VI. FLAT FILLISTER HEAD SCREWS.

A = Diameter of Body.
$B = 1.6A$ = Diameter of Head.
$K = 0.65A$ = Thickness of Head.
$D = 0.235A$ = Width of Slot
$E = 0.5K = 0.325A$ = Depth of Slot.



Machinery, N.Y.

A	B	K	D	E	Threads per Inch.
.070	.1120	.0455	.0164	.0227	72
.085	.1360	.0552	.0200	.0276	64
.100	.1600	.0650	.0235	.0325	56
.110	.1760	.0715	.0258	.0357	48
.125	.2000	.0812	.0294	.0406	44
.140	.2240	.0910	.0329	.0455	40
.165	.2640	.1072	.0388	.0536	36
.190	.3040	.1235	.0446	.0617	32
.215	.3440	.1397	.0505	.0698	28
.240	.3840	.1560	.0564	.0780	24
.250	.4000	.1625	.0587	.0812	24
.270	.4320	.1755	.0634	.0877	22
.320	.5120	.2080	.0752	.1040	20
.375	.6000	.2437	.0881	.1218	16

The diameters at the bottom of the thread and in the angle at the pitch line, are given in columns 2 and 3, Table II., as also the excess of pitch diameter over that of the basic standard, in column 4.

Each standard for tap gauges to have the diameter, number of threads per inch and "M. S. Standard Tap" plainly stamped thereon, as shown in Fig. 3.

Standard reference thread gauges for screws and taps should be used *only* for comparative calibration in making working gauges for such screws and taps, and to detect by such measurement the wear of the working gauges in actual service.

Working Gauges for Screws and Taps.—The working gauges for screws should be made of unhardened steel, and be exact duplicates of the standard reference thread gauges for screws, in external diameter, in diameter at the bottom of the thread, in pitch and in diameter measured in the angle of the thread; each working gauge for screws to have the diameter, number of threads per inch and "M. Screw" plainly stamped thereon.

For inspection of screws, your committee recommends the use of templet thread gauges, made of steel, hardened, double end, plus and minus limits respectively, the holes being tapped to represent accurately the limits for screws recommended in the report. The thickness of these templet thread gauges for each size screw is given and is designed to admit at the maximum end all screws that are within the limits, and to reject all that are larger, while screws smaller than the minus end of the templet gauge are thus shown to be less in diameter than is specified by the minimum limit recommended by your committee.

The working gauges for taps should also be made of unhardened steel, and to be exact duplicates of the standard reference thread gauges for taps, in external diameter, in diameter at the bottom of the thread, in pitch and in diameter measured in the angle of the thread; each working gauge to have the diameter, number of threads per inch and "M. S. Tap" plainly marked upon it.

The handles of all working gauges to be of a form easily distinguished from that of the reference gauges.

Proportions for Machine Screw Heads.—In Tables III., IV., V. and VI. are details of standard proportions for round head, flat fillister head, oval fillister head and flat head machine screws. These specifications are all based upon the diameter of the screw, thus reducing the calculations to their simplest forms.

The screws considered by the committee have been confined to those used in great quantities by large manufacturers and are the class of production by machine screw manufacturers which are made from screw gauge wire and having the heads formed by pressure. These are, therefore, known as press-head screws. They differ accordingly from those made by milling operation from stock of the nominal head diameters. The latter forms a comparatively small proportion of the total production of so-called machine screws, and while in the aggregate are also largely used, are in many cases made to suit the requirements of the various manufacturers of machinery and machine tools, many of these being larger in body diameter than those which the committee was asked to consider. If the latter class of screws are to be standardized, a special committee might properly undertake this, and thus supplement the work already accomplished by the present committee.

* * *

Don't forget that the rest of an emery wheel should never be allowed to stand more than one-sixteenth of an inch from the wheel, and sometimes it should be even much closer.

SPECIAL BORING RIG.

A positive pressure rotary blower is used by the American Gas Furnace Co. to supply the air blast for the gas burners of their furnaces. The casing for this blower is cylindrical in shape but must have an elliptical instead of a cylindrical bore, because of the peculiar construction adopted for the runner of the blower. The boring and facing rig shown in the accompanying illustration is used for machining this cas-

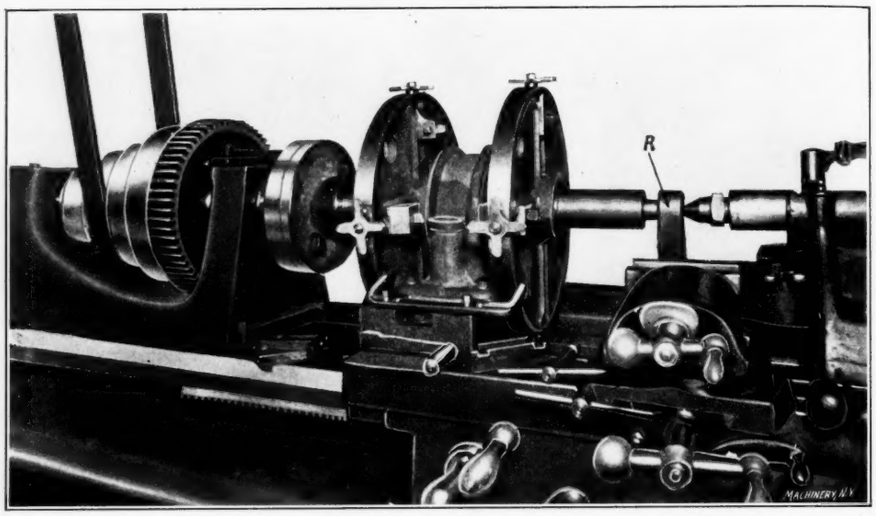


Fig. 1. Special Boring Rig for Finishing Elliptical Blower Casings.

ing. The rig is mounted in an ordinary engine lathe as in Fig. 1, the bar being driven by a flange bolted to the faceplate of the lathe, while the tail-stock end is supported by a rocker, *R*, pivoted to an arm attached to the tail-stock and kept in place by the tail-stock spindle, which bears against the rocker and forces it tightly against the end of the bar. In Fig. 2 the boring of the blower casing is shown in progress. In this illustration *A* is the boring bar, *B* the cutter head, and *C* and *D* faceplates carrying the cutters used for facing the two ends of the casing. The boring bar, *A*, has a longitudinal hole bored through it in which the shaft, *F*, is a running fit. The outer end of this shaft is squared to fit a square socket in the rocker *R*, and is thus kept from turning while the bar itself, which is driven and held in place by the lathe face-plate, rotates on the central shaft *F*. The right-hand end of shaft *F* carries

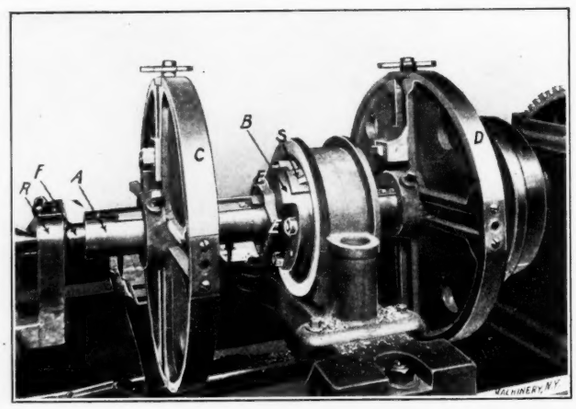


Fig. 2. Rear View of Boring Rig.

a cam, against which bear the inner ends of two tool slides, one of which is shown at *S*. These slides are held against the cam face by the springs, *E E*, the springs being connected by two short bars which bear against pins attached to the cutter slides, *S*, and extending through slots in the cutter head. As the bar rotates, the tool slides move in or out according to the inclination of the cam face and the bore of the casing is thus made to deviate from a true cylinder the required amount. After the casing is bored it is then faced by moving up the two faceplates as shown in Fig. 1, until the

cutters inserted in the tool blocks are the required distance apart and are located correctly in respect to casting. There are two sets of cutters used, one set leading the other one and roughing out the casting, after which the second set takes the finishing cut. The usual star feed is employed for these cutters, projecting pieces being clamped to the lathe carriage, against which the arms of the star wheels strike at each revolution.

* * *

AN ENGINEER'S COMMENTARY ON HIS OWN WORK.

No man has been more closely identified with the important engineering work of California and the Pacific Slope than Mr. George W. Dickie, the author of the interesting biographical article upon W. R. Eckart, the veteran mechanic and engineer, which we publish this month. Mr. Dickie's life work has been upon the Pacific Slope and mainly in connection with the Union Iron Works of San Francisco. The success of this firm in shipbuilding and marine engineering is due largely to his foresight and enterprise and the support accorded him by influential friends in the business world. In 1881 he saw the necessity for some concern near San Francisco to equip for steel shipbuilding and repairing, and as a result of his enthusiasm and persistent efforts the new Union Iron Works were founded through the consolidation of interests supporting Mr. Dickie with the engineering firm of Prescott, Scott & Co. The new plant was located on a large tract of land at the Potrero and was adapted in every way to the needs of the shipping interests of the Pacific and of San Francisco harbor. Four or five years after the works were established the new navy began to take definite shape and twenty naval vessels have since been built there for the United States government. An average of about 3,000 men have been employed.

Three years ago the Union Iron Works were absorbed by the United States Shipbuilding Co. and the original owners disposed of their interests, Mr. Dickie retiring from the management. The best years of his professional life, however, were devotedly given to the important and successful work of this company; and this will be the great achievement of his career, however important his accomplishments in years to come.

In a presidential address given last December before the Technical Society of the Pacific Slope, Mr. Dickie spoke in a reminiscent way of his engineering experiences and particularly of his years of labor for the upbuilding of the shipping industry through the establishment and maintenance of the Union Iron Works. He added, however, a thoughtful commentary upon his long connection with this firm, which deserves to be read by every professional engineer. That the life of the engineer must be a strenuous one, self-contained and perhaps narrow, is all too true. Happy will be the man if, in his younger years, he trains himself to heed the lesson implied or expressed in this part of Mr. Dickie's address, which we print below.

"There is a condition that the technical man who labors long in one line of work is very apt to fall into, and which my present experience enables me to speak knowingly upon; that is where a man practically loses himself and is lost also to others in his work. For 22 years I had given myself up entirely to the work as I found it at the Union Iron Works, going from my home every day direct to the works at Potrero; thus I was never seen in the city in the daytime, and those who knew me as a familiar business figure in the main business streets of San Francisco at first missed me, then gradually forgot me, except as they heard from time to time what was going on at the works. When I had to begin again this year to look for the people who had been my friends so many years ago I found myself in a strange city and among people who hardly remembered the friends I was seeking for, and while many knew my name and something of my work and reputation, yet I have lost my hold on the active men of to-day because I had lost myself and all my friends in the deep grave I had dug for myself in the Potrero. We want to love our work and put all our heart and soul into it, but we must not allow ourselves to be utterly lost in it, for I am finding that after being buried for 22 years in a comfortable shipbuilding and engineering grave, the necessary resurrection is a sort of a Rip Van Winkle return to places where I have long been forgotten.

"It is one of the evils of our profession that he who is able to accomplish anything worth while in it runs the risk of losing himself entirely in the effort. This is partly the result of the technical education that engineers receive, which absorbs much of the time usually devoted by young men in mercantile pursuits to social intercourse. In early life the engineer gets entirely absorbed in his profession, the very language of which is an unknown tongue except to his professional friends. The technical man gradually becomes self-constrained; he is not understood in the society in which he should move, so, late in life, when he needs companionship other than that of the shop, and tries to get into the place in life that he should have always occupied, he finds that no place has been reserved for him and that he must either go back to his old grave that fitted him so well, or industrially set about digging a new grave, probably to die in the effort.

"It is this intense struggle that never ends with the engineer if he is to keep abreast with the progress in engineering science, that renders him such a dreary neighbor and chills the social atmosphere all about him; nor do I see any salvation unless he is willing in early life to cultivate more than he ever has done the social habit, and to be able to take delight in the beautiful things around him, to see more in a waterfall than so many horse-power, to be intimate with the things people generally like to see and hear about. We boast very much about the vast achievements of modern engineering, and rightly, too, but it might not be easy to sum up what the development of engineering has added to the sum total of human happiness.

"When I look back upon my own engineering experiences I do not find anything that looks now very noble or really worth a man's putting his life into, although a lot of it may have been useful enough at the time. I see only a confused mass of iron beams and steel shafts, hear only the din of wheels and the roar of steam, with here and there a little gleam of something better, and when my memory catches these little bright spots in the picture I find that these were the days when I escaped from engineering and with the wife of my youth got away from the clang and the clamor of these man-made forces, and for a little while crept into the bosom of mother nature, listened to her soothing music, heard the beating of her great heart and rested happy in the though that I was, after all, one of her children who had tired himself out in fighting her forces. It is a comfort to be able to recall the times and places wherein I came nearest to being happy and to know that these spots are never closed to those tired of the struggle with stubborn circumstances, and it may be that the next hole I creep into will be among the beautiful Santa Cruz mountains. No, it will not be a hole, but "Loma Linda," the hill beautiful, and to such a place, if I get there, it will be my delight to draw many a weary technical that he may learn his child lesson that life is vastly more than an engineering problem."

[Loma Linda is a beautiful country place of 200 acres owned by Mr. Dickie in the Santa Cruz Mountains. The house was destroyed in the great earthquake.—Editor.]

* * *

The business of Westinghouse, Church, Kerr & Co. of New York has been purchased by Kean, Van Cortlandt & Co., and will be reorganized. The president of the new concern will be John F. Wallace, the Panama engineer whose resignation from the commission a few months ago caused such a stir. The great development of engineering work, particularly the terminals of important railroads, has made necessary a more powerful construction company than the old firm of Westinghouse, Church, Kerr & Co., or in other words one having greater capital. The new company, it is stated, will have a capital of $12,000,000 and will start business with cash resources of $7,000,000. The Westinghouse interests will be represented by George Westinghouse, who will be on the board of directors.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1906.

PAID CIRCULATION FOR MAY, 1906,—22,624 COPIES.

MACHINERY is published in four editions. The practical work of the shop, s thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE WELFARE WORK OF THE NATIONAL CIVIC FEDERATION.

The interesting photographs of the Homestead, Pa., Club, published in the Engineering edition for last month, were furnished through the courtesy of the Welfare Department of the National Civic Federation, New York city.

The Welfare Department now has a membership of 200 employers, organized for the purpose of demonstrating what can be done to ameliorate the unsatisfactory conditions under which the employees frequently work or live. Conferences are held in different sections of the country, where experiences related by Welfare workers inevitably lead other business men to look within their own plants and adopt such features there as are applicable under the local conditions existing.

The first and most important step in any well-organized effort in this direction is to provide sanitary work places. This includes systems for supplying pure drinking water; for ventilation, including the cooling of overheated rooms and devices for exhausting dust and removing gases; for adequately lighting workrooms; for placing protectors about dangerous machinery; wash rooms with hot and cold water; shower baths for molders; emergency equipment; locker rooms; seats for women; lunchrooms, etc.

Next, after these conditions have been made as good as possible, it is feasible in many cases to go a step further and furnish facilities for recreation and education, such as club rooms, facilities for outings, night classes, etc. We are of the opinion, however, and experience in many cases bears out this view, that this last step is not always a wise one to take and unless made with a full understanding of the conditions and in entirely the right spirit it may lead to more dissatisfaction among employees than can be compensated for by the sum total of the benefits to be derived therefrom. It is well, therefore, that there is an association to assist manufacturers who are desirous of entering into welfare work, by giving them the benefits of the experience of others who have been successful and advising with them as to the proper course to be followed under the conditions which exist in any case.

* * *

Some trouble has been reported by machine tool builders who have used motor drives with the motors mounted at or near the tops of the frames of the tools, the trouble resulting from vibration due to the armature being out of balance. However perfectly an armature may be balanced when it leaves the factory it may be thrown out at any time by overheating the motor, and it does not seem in the line of good design to mount a motor on top of the frame of a milling machine or on top of the head stock of a lathe, for example, when every precaution has been taken to produce a machine tool within extremely fine limits of accuracy. It is certainly not possible to do a fine job of tool work on a lathe in constant vibration, however accurately the spindle and ways may be aligned. The tendency now is to mount motors on the base of the machine near the floor, or even on the floor itself. The all-gear drive for machine tools lends itself admirably to this arrangement, for it can be designed with the single driving pulley overhanging, allowing a clear way for the belt connection between this pulley and the pulley on the motor. One of the best examples of this arrangement is in the Flat Turret lathe, which has the overhanging pulley, and is easily driven by a motor on the floor under the head end of the lathe.

* * *

TWO GALLON AUTOMOBILE CONTEST.

Automobile contests have usually been conducted with no more important aim than to gratify the desires of a certain few of the sporting fraternity, who class sport and foolhardy exhibitions, like the race at Ormond Beach last April, as one and the same thing. The Automobile Club of America, however, should be given the credit for instituting an efficiency contest last month which must be of interest to everybody who has anything to do with automobiles, be he manufacturer or user. This is the two-gallon contest over a course starting at 57th St., New York, and extending north and east along the Connecticut shore through Stamford and New Haven. Each car started with exactly two gallons of gasoline in its tank and was to travel as far as possible with this small fuel supply. It was a handicap trial, the basis of comparison being a car with four or more cylinders. Allowances were made either in favor of or against other cars of different construction or weight to make the score fair to all. The distance traveled and the weight of the car, with a handicap of 800 pounds added, were used in figuring the score; but allowances were made to one- and two-cylinder cars, because of their supposed inferior efficiency. The first prize went to a four-cylinder Franklin of 12-horsepower, which covered 87 miles. Another Franklin car, however, of the same type, completed only 58.4 miles, indicating that the skill of the chauffer as an engineer had almost as much to do with the result as the design of the machine itself. In fact, while this trial had nothing of the spectacular about it, and would not ordinarily be classed with the Ormond Beach race as a sporting event, it was really a more complete test of the ability of the man driving the machine than was the latter.

While the two-gallon efficiency test was a move in the right direction, no results of great value to manufacturers are likely to be obtained except by means of laboratory tests of automobiles. It is a fundamental principle that no satisfactory results are ever reached by testing two elements of an apparatus at the same time. To really find out anything about the performance of an automobile we should know first what the rate of consumption of the engine is and second what is the efficiency of the transmitting mechanism. Such results, taken in connection with road trials would give manufacturers important data to base their work upon.

* * *

It is a disappointment to the advocates of concrete construction that there were no buildings of reinforced concrete in San Francisco by which the merits of this type of building for localities subject to earthquakes could be judged. The nearest to this type of construction, in principle, though not in form, was the Palace Hotel, a building with solid brick walls tied together by a large number of intersecting partition walls, which were also of solid masonry. This building had been built upon honor, with a good quality of cement or mortar and was as nearly a monolithic structure as could be produced without the use of reinforcing rods such as employed in concrete work. The Palace Hotel withstood the shock well, although other masonry buildings constructed in an inferior manner crumbled under the tremor. It seems reasonably certain that reinforced concrete will be used extensively in San Francisco for rebuilding the new city.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

In the November and January issues mention was made of the metal tantalum which is being developed commercially by the Siemens & Halske Co. of Berlin, Germany. Tantalum has characteristics that should make it very valuable for certain tools and purposes where extreme hardness, toughness and elasticity are requisites. As an example its use for pens is said to promise the displacement of steel and gold. Tantalum pens resist the chemical action of inks to a remarkable degree and are much harder and more elastic than steel pens; they are more elastic than gold pens and of course do not have to be tipped with iridium as do gold pens.

A curious product is mentioned in a United States consular report from Paris, France, being called calcium steel, although it is a ceramic product; it is made by baking a paste made of finely pulverized feldspar, sand and lime mixed in certain proportions. The product, however, has remarkable qualities, being a porcelain or earthenware of great hardness and durability. It resists corrosion by acids, is a poor conductor of heat and electricity, and has a specific gravity of only 3.3. Although hard, it is very tough and can be machined the same as metals, being readily bored, cut, planed or polished. One of the uses for which it is expected to be valuable is for pipes and conduits of water, gas, chemicals, etc.

Few of us have adequate appreciation of the machinery in any large city or town for the distribution of food supplies. The New York *Times* says that it was noted long ago by Archbishop Whately that the provisioning of London, though a task probably beyond the ability of the greatest of commissary officers backed by the authority of the government, was daily performed perfectly and easily by utterly unknown persons, each working, as it were, independently but, of course, in harmony with the law of supply and demand. In San Francisco the demoralization of the avenues of trade by the great earthquake threw an enormous task on the improvised commissary department of feeding the hundreds of thousands of people who had lost their homes and means of subsistence. A study of the difficulties of providing for people in such a condition only brings out more prominently the fact that under normal conditions most human beings are and must be largely self-regulating in their mode of life, and the same also applies in any shop or factory. The direction of work in a shop first of all requires that the workers shall be trained so that a word or hint is sufficient for them to proceed in an orderly manner to accomplish any task. When men are not so trained it means that a boss shall stand over them who shall direct every move. That the direction of work and the accomplishment of satisfactory results by "bossing" is one of the hardest things to do will be generally acknowledged by those who have had some experience.

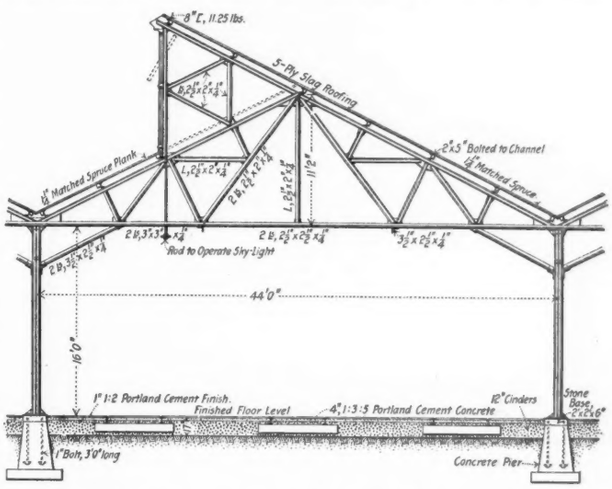
A curious effect was noticed in connection with a kinetograph view which was taken in Germany not long ago. It was obtained at the time of the visit of the King of Spain to Berlin, and represented the entrance of the procession into the city. The horse guards led off, then a line of carriages, and lastly a line of mounted cavaliers. What was surprising about this view was that while the carriages moved in the line of march as they should do, the wheels appeared to revolve slowly in the contrary direction, and thus the spectators had the impression that the vehicles were about to be dislocated and torn apart. In another view of the same scene the wheels did not turn at all, or else swayed slightly to and fro about the center. The phenomenon is easily explained, although at first it puzzled nearly everyone. To take the views we photograph the objects successively within at least one-tenth of a second, and then project them in the same order on the screen. In the case of a moving carriage wheel the rotation is suggested to the eye entirely by the displacement of the spokes. But here the kinetograph may be completely at fault. For instance, in one of the views a spoke of the wheel occupies a well-defined position. In the following views if the second, third, and fourth spokes are made to occupy exactly the place of the first in their turn, the successive images of the wheel will not differ from each other. The spectator will therefore not have the sensation of the wheel's movement. According to the relative speed of the wheel and the projection apparatus we may find that the successive spokes have a slight advance or lag relative to the position of the first one and give the illusion that the wheel is turning forward or back, as the case may be.—*English Mechanic.*

MODIFIED FORM OF SAW-TOOTH ROOF.

A modified form of saw-tooth roof is described in the *Engineering News* by M. S. Ketchum. This roof has been used for one of the shops of the Public Service Corporation of New Jersey.

The principal advantages of the modified saw-tooth roof are that it allows the use of ordinary valley gutters, and gives an opportunity to take care of the condensation on the inner surface of the glass by suspending a gutter at the bottom of the monitor leg. Snow will cause very little trouble with this roof on account of the increased depth of gutter. The modified saw-tooth roof has a greater pitch, and permits the use of a more economical truss for long spans than the common form of saw-tooth roof.

The roof is a five-ply slag roof laid on 2-inch tongued and grooved spruce sheathing, which is spiked to 2 x 5-inch spiking strips bolted to 8-inch channel purlins spaced 6 feet on



centers. The roof water is carried down 5-inch cast iron leaders attached to alternate interior columns. The sash in the vertical leg are in two rows, the upper row being hinged at their centers, thus providing ample ventilation. Condensation gutters are placed below the vertical leg (on the inside) to take the drip. The skylight area is about 20 per cent of the roof area, the window area is about 45 per cent of the outside walls; thus about 28 per cent of the entire outside surface of the building is of glass. All glazing is of ⅛-inch ribbed wire glass, with the ribs placed vertical. The skylight frames and moldings are made of No. 24 galvanized iron, while the entire roof is flashed with 16-ounce copper sheets, 4 feet wide, and counter-flashed with sheet lead.

In a short article by Mr. W. S. Butcher on the photographic reproduction of blueprints in the *Engineering News* the writer says there is a growing tendency in engineering offices to invoke the aid of photography for the purpose of reducing large plans to convenient size both for filing and for use. It is generally possible to show on small reproductions all the necessary details which on a blueprint require the use of large and

cumbersome rolls or portfolios. Photography is also of use for reducing plans of various scales to a uniform scale and is desirable when making assembled drawings, or tracings. To make photographic reductions directly from blueprints is a difficult matter inasmuch as the actinic value of the light reflected from the blue and white parts of the blueprint is nearly equal, and hence a negative made from a blueprint under ordinary light conditions is entirely too faint for making prints. Some success has been attained by changing the blue to green by chemical process but it soon fades away, thus destroying the original. The described method of photographing blueprints depends upon the well-known fact that the blue background absorbs all the colors of the light coming to it but the blue rays so that if the blue rays are cut off from the source of light the blue portion will appear black. To photograph the white lines successfully when the blue rays are stopped off it is necessary to use orthochromatic or isochromatic plates which are sensitive to orange rays. The operation of taking a negative is best performed by covering a window facing the south with two or three sheets of orange colored paper in front of which the blueprint is set up and photographed in the ordinary manner. A somewhat extended exposure is required amounting in most cases from 10 to 15 minutes, the time of course depending upon the intensity of the light.

REMARKABLE LOGARITHMIC TABLES.*

CALCULATED AND PRINTED BY MACHINERY.

There is in the Society's library a book, the peculiarity and value of which is entirely unknown to practically all of its members. Though it is printed in a foreign language, it may be used with ease or consulted by any of the members, it being a TABLE OF LOGARITHMS.

To demonstrate the above quoted "peculiarity and value" of this work, the undersigned has made a translation of the preface to it, which explains its manner of computation and make-up, etc., and which is herewith respectfully submitted for the information of the Society. The tables are arranged on the same principles as the well known "Vega's Tables."

Respectfully,

G. A. M. LILJENCRANTZ, M. W. S. E.

The Preface.

It is a well known fact to every mathematician that the usual method employed for obtaining logarithm tables does not offer sufficient guarantee against misprints. The only means of making such tables fully reliable is undoubtedly the use, for their calculation, of an apparatus which accomplishes both the calculation and the printing or stereotyping of the procured quantities.

The proofreading, upon which the reliability almost exclusively depends, will then be reduced to a mere trifle, and becomes exceedingly easy, for the only proofreading then required is that concerning the difference between the trigonometrical logarithms, for the calculation of which the machine will, as may be easily conceived, serve as a "setting machine."

This circumstance suggested to me, as much as twelve years ago, the idea of publishing logarithm tables, by aid of the calculation machine previously invented by me.

The accomplishment of such a work, however, would have involved far greater expenditures than my personal means permitted, and my plan would probably never have been executed had not our present King, His Majesty Oscar II, then Duke of Oestgothland, taken the initiative to and supported the formation of the so-called: "Wiborg's Table Stock-Company (Wiborgska Tabell Actie Bolaget), in which the most prominent magnates of Sweden took shares.

For the liberal generosity of this Association, through which the publishing of these tables has been rendered possible, I wish to extend my warmest gratitude.

According to the plan devised by me, the machine was to print the computed quantities in lead, from which were to be made galvanoplastic reprints in copper, from which the desired tables should then be printed.

The realization of this plan was, however, found to be combined with far greater difficulties than had been anticipated. Much time was consumed in overcoming these difficulties; hence the work has not been completed until now, after years of struggle.

It is presented to the public under the conviction that the mathematician will consider the greater reliability it offers over tables produced in the usual manner, as fully compensating for the lack of ornamentation in typographical respect, that others may possess as compared with these "machine-made" tables. A work of attractive appearance, typographically, is much easier to produce in the usual manner than by a calculation machine. The difficulties in forming perfectly straight lines by the machine printing are naturally very great. The first one is to get the figures engraved with minute exactness in the different printing wheels. This successfully done, it may happen that in the hardening of the wheels some of these may warp more or less. The least wear, furthermore, tends to make the figures more or less uneven. A different density of the lead, or the material in which the machine is made to print, or uneven pressure, causes also a crowding, which has a bad effect on the regularity of the lines. No attempt to compete by this method of printing with that usually employed, as regards the typographical appearance, can therefore be considered.

I hope, however, that to anyone who buys the tables with the object of *using them*, the work will prove satisfactory.

Concerning the arrangements of the tables, these are in the main in accordance with those of Bremiker and Dupuis.

Stockholm, in November, 1875. M. WIBORG.

* From the proceedings of the Western Society of Engineers.

DANGER OF A SHORTAGE IN IRON.

Consul-General Mason, of Paris, has gathered statistics upon the world's supply of coal and iron. While there has been much talk, at one time or another, about the exhaustion of the anthracite coal supply, it will be a surprise to many to learn that the danger in a shortage of iron ore is even more imminent. The world has only 10,000,000,000 tons of iron ore available. Of these, Germany has twice as many tons as the United States. Russia and France each has 400,000,000 tons more than this country. Our annual consumption is placed at 35,000,000, which is more than a third of the world's total consumption.

Several months ago the Parliament of Sweden, then in session, adopted a resolution, calling for a report showing the extent of the known deposits of iron in Sweden and other countries, and the rate at which such deposits are being consumed by the steadily expanding iron and steel industries of the world. The report was made by the chief of the Swedish geological survey, together with comments by several other experts. While there has been some dissent as to the exactness of certain details, the report has been accepted as substantially accurate.

Condensed to their smallest compass the statistics of the report give the following comparative exhibit of the whole known amount of workable iron ore yet available in the several iron-producing countries. The present annual output of ore, and the amount of ore actually consumed by each, is as follows, in tons:

Country.	Workable Deposits.	Annual Output.	Annual Consumption.
United States	1,100,000,000	35,000,000	35,000,000
Great Britain	1,000,000,000	14,000,000	20,000,000
Germany	2,200,000,000	21,000,000	24,000,000
Spain	500,000,000	8,000,000	1,000,000
Russia and Finland.	1,500,000,000	4,000,000	6,000,000
France	1,500,000,000	6,000,000	8,000,000
Sweden	1,000,000,000	4,000,000	1,000,000
Austria-Hungary ...	1,200,000,000	3,000,000	4,000,000
Other countries	.....	5,000,000	1,000,000
Total	10,000,000,000	100,000,000	100,000,000

While it is probable that the foregoing statement does not take into adequate account the undeveloped ore deposits in Utah and Alabama, its teachings are nevertheless obvious. Of the world's workable iron-ore deposits, as at present known, the United States possesses only about one-ninth, and at the present rate of consumption the entire supply will be exhausted within the present century.

It is well known that the high-class ores of the lake district in America will, at the present rate of consumption, be ex-

hausted within less than fifty years. The Mesaba deposits, with the present annual output of 12,000,000 tons or thereabouts, will not outlast twenty-five years, and it requires only a simple calculation to demonstrate that a continued yearly consumption of 35,000,000 tons of ore by the iron and steel industries of the United States will, within the lifetime of many persons now living, eat away entirely the 1,100,000,000 tons which, according to the report above cited, constitute our country's entire workable supply as at present known. Inasmuch, therefore, as the United States possesses but about one-ninth of the world's ore deposit and yet consumes more than one-third of the total annual output from all countries, the conclusion is direct and unavoidable that the future economic policy of American iron masters should be to secure, by all practical means, the largest possible ore supply from the mines of other countries. How can this be most economically and effectively accomplished?

The problem is largely one of transportation in which the item of marine freight rates plays a dominant part. An economic long-distance ocean rate for heavy, low-class merchandise, involves necessarily two conditions, viz., vessels specially adapted to the trade, and return freights that will bear an equal or higher charge for transportation. The ship that brings ore from Spain, Sweden, and other European countries to the United States, must have each trip an eastward-bound cargo that will be more than ballast and yield a regular and definite profit. There is but one material which will meet the requirements of the case, and that is coal.

It is in respect to quantity and quality of coal supply that the advantage of North America over European countries is decisive and overwhelming. Whatever may be the facts concerning ores, the known coal measures of the United States render their fuel supply secure, abundant, and of excellent quality for centuries to come. There are hundreds of thousands of acres of gas and coking coals of high quality in the Appalachian region—to say nothing of other fields—which have as yet been hardly scratched by the pick and drill of the miner. New coal deposits of greater or less extent and value are being discovered from year to year. With what is now known the present enormous annual output of 280,000,000 tons of bituminous coal can be maintained for hundreds of years without exhausting the available supply. In Europe, on the contrary, the years of adequate coal provision are definitely numbered. In England experts estimate the duration of the workable coal measures to be from sixty to one hundred years. Germany has a somewhat longer lease of industrial life dependent on coal supply, but already the subject is so acute that a heavy contract for the delivery of German coal to France, for iron and steel works, is understood to have been canceled recently at heavy loss to the sellers, because, as it is definitely understood, the Imperial government objected to the depletion of the national coal supply for the benefit of neighboring countries. France has native coal for a generation or more, but the mines are deepening, the cost of production is gradually increasing, and economists are looking with growing apprehension to the future. Twenty-five or at most thirty years hence, the question of an adequate fuel supply will be a serious problem for France.

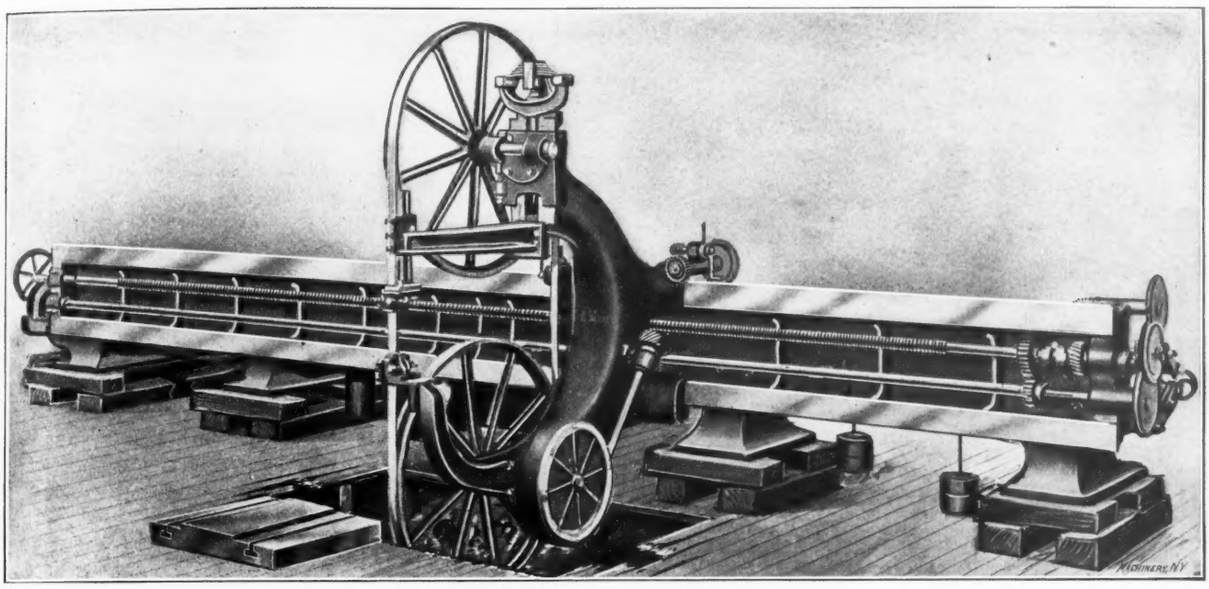


Fig. 1. Band Saw for Trimming Armor Plate.

BAND SAW FOR ARMOR PLATE.

The accompanying half-tone and line-cut illustrations, taken from *Engineering*, show an interesting band-saw machine tool for sawing armor plate, which was designed by Mr. L. Schechter and built at the Kharkow Locomotive & Engineering Works, South Russia. The half-tone shows the band-saw head and the supporting rail, but not the work tables or the bed plate supporting them. In the setting of the machine a pit is provided for the traverse clearance of the lower half of the bottom pulley, which part is below the floor level. The cross section, Fig. 2, shows these clearly, and Figs. 3 and 4 give

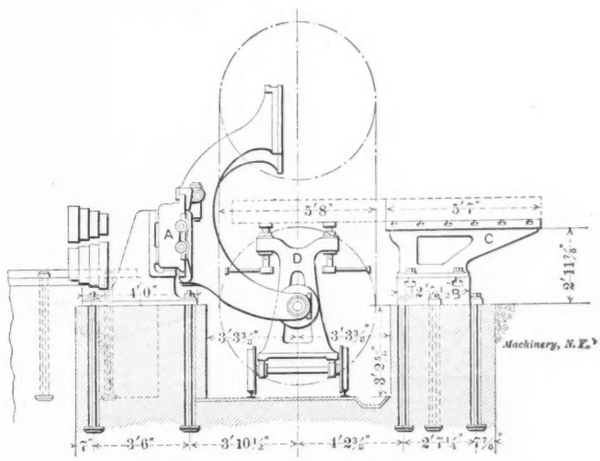


Fig. 2. Cross-section of Machine.

the end and side elevations together with some dimensions. The plate to be trimmed or sawed in two is laid upon *C*, where it remains stationary, being clamped to the table. The band-saw head traverses on the rail *A*, power being communicated to it from a 5 H. P. constant-speed electric motor through the splined shaft *D*, while feed motion to the head is transmitted through the screw shaft *C;* the rate of feed is varied by the well-known Sellers friction disks, shown at the right. The machine has a capacity for cutting armor or other plate up to a thickness of 5.9 inches, a width of 5 feet 7 inches, and

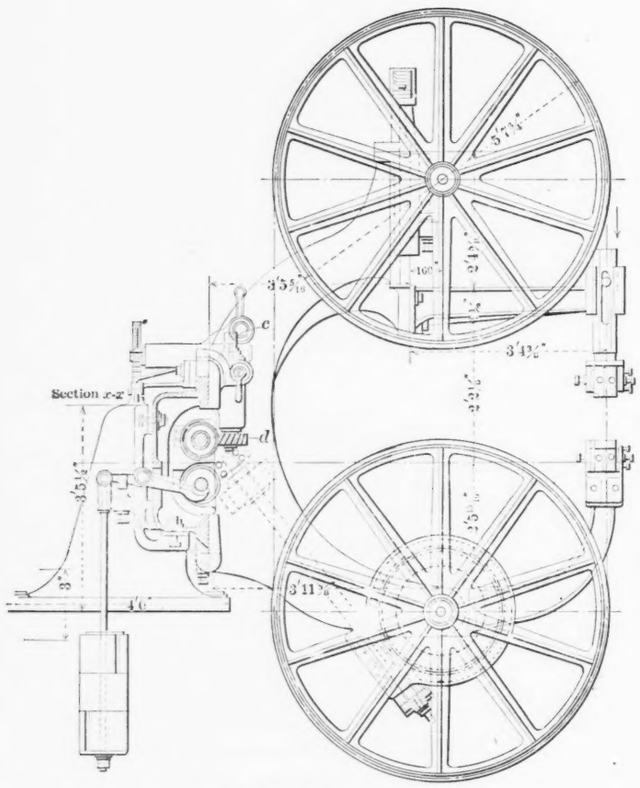


Fig. 3. End View of Traveling Saw Frame

a length of 27 feet 10 inches at one setting. The bed-plate *B* supporting the tables is 31 feet 2 inches in length and on it are bolted six tables, each 21⅝ inches in width. The plate to be sawed is clamped on the tables while the portion to be cut off rests on the movable supports *D*. The band-saw pulleys are each 5 feet 7¾ inches diameter with a face for a 4-inch saw; power is communicated through the lower pulley from the motor, which runs at the constant speed of 1,120 revolutions per minute. The circumferential cutting speeds at which the saw is run are about 12¼, 18⅛, 26, and 36¼ inches per second, the changes being made on a four-step cone pulley. When used for cutting armor, say 5.9 inches thick, the cutting speed of the saw is about 18⅛ inches per second. The feed motion may be varied within the limits of 0.08 to 3.03 inches per minute.

THE DEVELOPMENT OF THE GAS ENGINE.

From a Paper by C. E. Sargent upon "The Prime Mover of the Future," before the Western Society of Engineers, December 6, 1905.

The economy of the internal combustion engine has been recognized from its inception. Both the theoretical and practical efficiency of this type of prime mover is from two to five times greater than that of the average externally fired heat engine. The smallest gas engines have a thermal efficiency from 20 to 24 per cent, while the largest steam engine, with all modern refinements known to the art, does remarkably well to turn into work 12 per cent of the heat supplied to the furnace under normal conditions. For well known reasons the thermal efficiency of steam engines increases with the cylinder volume, but although this increased efficiency is not so apparent in internal combustion engines, a comparison of the thermal efficiency of an ordinary gas engine with the largest and most economical engine propelled by steam, while perfectly fair to both types, still shows 100 per cent in favor of the internally fired prime mover.

A plant recently tested by the writer in which producer gas from anthracite culm was used, showed the cost of fuel per horse power hour to be about 1.5 mills. By selling the by-products of the bituminous gas producers at the market price, a recent writer in *Power* claims that power from gas engines can be generated 14 per cent cheaper than from water falls.

As the efficiency of the steam plant depends largely on the rapid transmission of heat through boiler walls, and the efficiency of the gas engine on our ability to prevent heat from passing through, the gas engine cylinder can be very much thicker and stronger than the boiler shell, and while the pressure during rapid combustion exceeds the pressure usually carried in the steam boiler, accidents from ex-

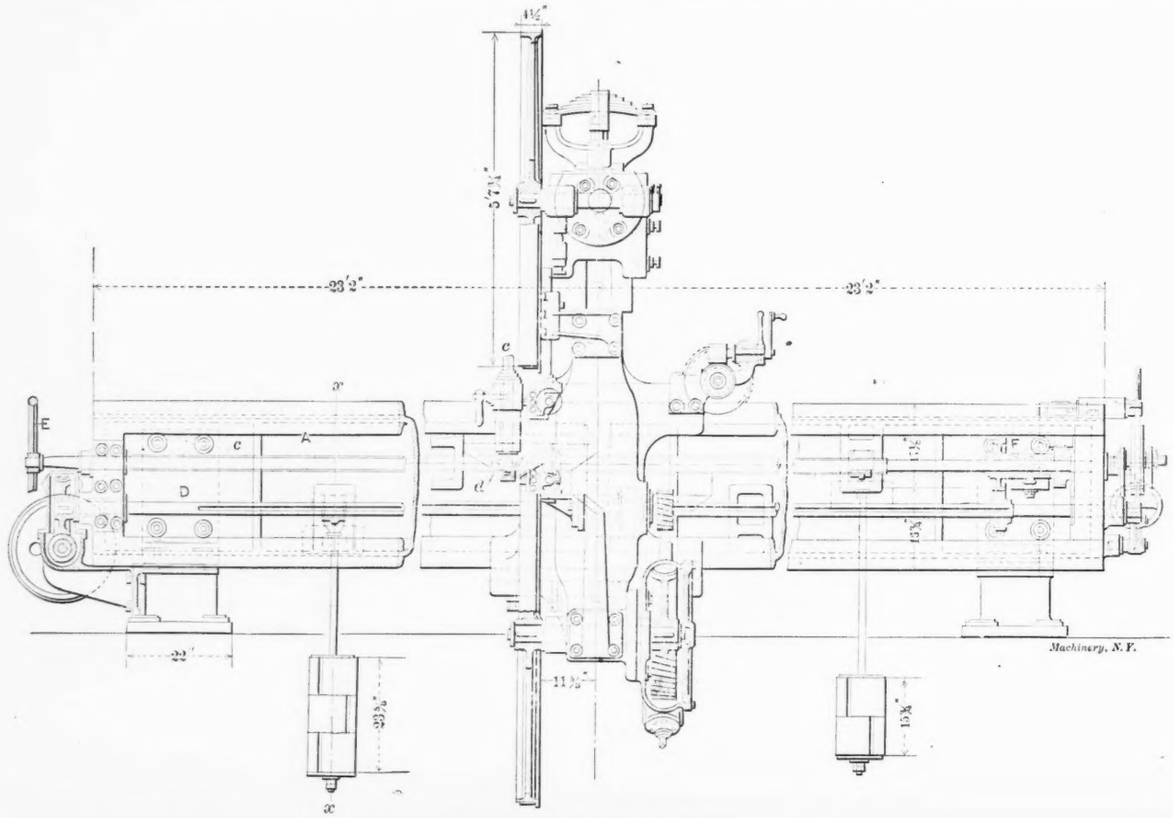


Fig. 4. Front Elevation of Band Saw.

ploding cylinders are almost unknown, and accidental gas explosions doing considerable damage, very rare.

The first cost of a large gas engine plant, including producers, coal handling apparatus, piping, scrubbers, cleaners, building, compressor and engines is not far from that of a steam plant complete, including boilers, engines, pumps, condensers, chimney, piping and all accessories, so we can assume the first cost the same in each case. Since great pressures are not maintained in gas engine installations as they are in boiler plants, the depreciation from internal strains and corrosion should be considerably less. Gas engines do not wear out any quicker nor do they need any more repairs than steam engines. Gas producers are long lived, the apparatus requiring but little attention and few repairs. The Erie R. R. Co. have had two 200 H. P. producers in operation at Jersey City for seven years and the fire in one has never been out. Imagine the condition of a boiler after such a run. Although the cost of operation including oil, waste, packing, purgers and labor would no doubt be less for the gas engine installation than for steam, no claims for savings are made on this account.

Stand by losses are much less in the internal combustion engine plant if run intermittently or if part of the equipment is held in reserve for immediate service. The gas holder with the producer provides for the peak of the load even though the producer is run at a uniform rate. With sufficient capacity of holder the gas producer may be run with a uniform output for every hour out of 24 though the engine load vary through the widest possible range, and running under such conditions, there are practically no losses from radiation or leakage, as would exist in a boiler plant under pressure.

The California Gas and Electric Corporation, which normally gets its power from waterfalls two hundred miles away, carries a gasometer full of coal gas always in reserve for use in gas engine units, should the long distance power fail.

When compressed air is available, and all large units use this medium, gas engines of any size can be started and can take the full load in two minutes' time as no warming up or cylinder draining is necessary. The waste heat, about 70 per cent of the heat supplied, can be used for heating and a higher temperature can be maintained than with the heat from a steam engine exhaust. If the internal combustion engine has so many advantages over steam, why, then, has it not had greater development? Why are we not using gas engines in our large power plants? Why are we using 40,000 B. T. U. instead of 10,000 B. T. U. in generating a brake horse power? Why are we burning 400 cubic feet of waste gases under our boilers to evaporate sufficient water for a horse power hour when 100 cubic feet burned behind the piston would do the same work? Simply because the American manufacturers have not kept pace with the development of the gas engine as a prime mover.

Five years ago when Mr. Henry Wehrum, who has probably done more to introduce the gas engine for power for steel mill work in the United States than any other man, wanted one and two thousand horse power gas engines for the Lackawanna Steel Company's plant at Buffalo, there was practically but one engine obtainable and that of foreign make. A few months ago when the Carnegie Company wanted engines of the same size for the Edgar Thomson Works, twelve proposals were received from American manufacturers.

While the Europeans in order to manufacture at a profit, on account of the high price of fuel have been driven to the gas engine for power, the largest internal combustion engines ever made are of home product. It is said that a representative of the United States Steel Corporation went to Europe to investigate the gas engine for steel mill work. After visiting several plants which were in successful operation, he said that they worked very nicely for small engines, but he would like to see the largest engine ever built, whereupon he was advised to go home and see the 4,500 H. P. gas engine built by the Snow Steam Pump Works. This company has running and is having installed 25 internal combustion engines having a total capacity of 48,000 H. P. The largest engine ever built, a twin tandem 52 inches by 60 inches, 5,400 B. H. P., is now being erected for the California Gas & Electric Corporation, and three others of the same size will follow.

The De La Vergne Machine Company have built nearly 50,000 H. P. of two and four cycle gas engines and have 40,000 H. P. installed in the Lackawanna Steel plant at Buffalo, N. Y.

The Westinghouse Company is installing engines of 2,000 H. P. and at least half a dozen manufacturers in the United States will take contracts for any size.

Such has been the growth of the internal combustion engine since 1900, yet the beginning of the present gas engine era, in the United States at least, dates from the expiration in 1890 of the fundamental four cycle patent of Dr. Otto. Of course there were several attempts to make commercial gas engines of the six-cycle or two-cycle type before this time, but with the exception of a few two-cycle marine engines and the imported Koerting, the other attempts have been abandoned. It would seem that the owners of so valuable a patent as that of the Otto cycle, while the protection lasted, would have used every effort to develop a large and remunerative business, but there are several reasons why more progress was not made by the owners of the American rights, while they enjoyed the exclusive monopoly of the only successful gas engine cycle at that time.

In the first place, the firm itself was impregnated with a certain amount of Teutonic conservatism, which prevented the progress one would expect from a live American manufacturer; even the directions for using the Otto gas engine, a 16-page pamphlet, were sold for 25 cents a copy. Then again, only illuminating gas, which in those days cost more money than it does now, was available for fuel, and with a very high-priced engine, upon which the general public looked with more or less suspicion, the advantages of the internal combustion engine over steam engines were questioned. But when it was found that the by-product of the refinery, gasoline and distillate, were available for fuel, and the fundamental patent had expired, the era of the internal combustion engine began to dawn. Manufacturers who had been experimenting with engines of the two-cycle and Brayton type, began to build engines of the Otto cycle, and to-day there are upwards of five hundred manufacturers of gas engines in the United States alone.

The largest gas engine exhibited at the World's Columbian Exposition, thirteen years ago, was of only 35 H. P.

The opening of natural gas wells and the invention of practical producers have provided a cheap fuel for the internal combustion engine, and the utilization of a by-product of the coke ovens and blast furnaces—an excellent gas engine fuel, have given the present impetus to gas engine manufacturers.

While the work done by the gas engine required no niceties of regulation, like driving a dynamo or textile machinery, a single cylinder engine with an impetus or blow when loaded every second revolution and when running light once in a while, was a satisfactory source of power, but with the necessity of a better turning moment and better governing, more cylinders were added, thereby increasing the impulses per revolution, or the admission was throttled, reducing instead of the number of explosions, the mean effective pressure of each impulse.

As the highest possible compression without danger of premature ignition is conducive to the highest efficiency, the hit-and-miss method of governing is a more economical method than reducing the charge, but the advisability of a close regulation and uniform rotation makes the latter method imperative.

As the exhaust stroke of a four-cycle, single-acting engine has no compression to bring to rest the reciprocating parts and as a triple or quadruple crank is not only expensive to build and maintain in alignment, but as the work on one crank must be transmitted through other cranks, there arose a demand, in the minds at least of engineers, for a double-acting gas engine, which, if made tandem, even with the four-cycle, would give not only an impulse for every stroke, or twice during a revolution, but the reciprocating parts would be brought to rest by the compression indigenous to each stroke.

A 60-H. P. engine, embodying these features, designed in 1897, was, to my knowledge, the first successful double-acting engine ever built, though Dick Kerr & Co., of Kilmarnock, Scotland, had built a few both four and six-cycle tandem engines, two of which had a brief existence in a central lighting station at the corner of Clark and Lake Streets, Chicago, in '95 or '96.

At the Paris Exposition in 1900 a 1,000 H. P. single-acting single cylinder Cockerell engine was known, but the double-acting tandem engines now building by most European and many American manufacturers, were conspicuous by their absence. With a tandem construction, with a single crank we can get as many impulses as with a single steam engine, and with a twin tandem, as many impulses as with a cross compound engine. With this type approaching as it does, the steam engine design, the driving of multiphase generators in parallel is readily accomplished.

THE THEORY OF THE HATCHET PLANIMETER.

The construction and operation of the "hatchet planimeter" were described in the September issue of MACHINERY. The simplicity of the instrument, considering the comparatively complex nature of the problems it has to solve, lends considerable interest to the question of the principle on which it operates. In the following paragraphs is given an explanation based on an article on this subject which appeared in the *Revue de Mecanique*, issue of July 31, 1905. Liberties have been taken with both the translation and method of the proof.

If the stylus end of the planimeter shown in Fig. 1 be made to follow any straight or curved line, such as $T\,T$ in Fig. 2, the hatchet end will describe a curve, $M\,M$, whose character will vary with the relative positions of line $T\,T$ and the starting point of the hatchet end. Let $A\,B$ represent the location of the axis of the planimeter when the stylus has reached A, and $A'\,B'$ the corresponding location when the stylus has reached A'. $A\,B = A'\,B' = l$ on the planimeter shown in Fig. 1. Let it be required to find the area of the figure $A\,B\,B'\,A'$. This figure $A\,B\,B'\,A'$ can evidently be divided into an infinitely large number of little sectors of circles whose sides will make an infinitely small angle with each other. Assign to this angle a value $d\,\alpha$, and represent the sector by the dotted lines in Fig. 2. If a circle has a radius l, it will have an area of $\pi\,l^2$; therefore, the area of any sector of that circle whose sides make an angle $d\,\alpha$ with each other may be expressed thus:

$$\text{Area} = \frac{d\,\alpha\,\pi\,l^2}{360}.$$

Let α represent the total angular movement of the instrument in going from $A\,B$ to $A'\,B'$, or in other words, the angle $A'\,O\,A$ which would be included between $A\,B$ and $A'\,B'$ if the latter line were produced to meet the former; then, since angle α is the sum of all the little angles $d\,\alpha$, area $\frac{\alpha\,\pi\,l^2}{360}$ will be the sum of all the little areas $\frac{d\,\alpha\,\pi\,l^2}{360}$. So for any figure described as was $A\,B\,B'\,A'$,

$$\text{Area} = \frac{\alpha\,\pi\,l^2}{360}.$$

This formula is an expression of the following fact: The area swept over by the axis of a hatchet planimeter when

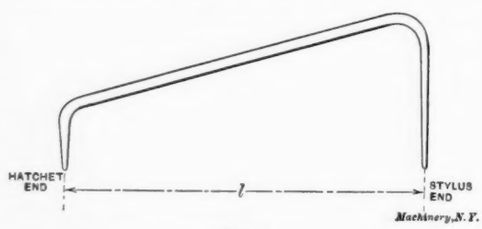


Fig. 1

moving between any two positions is equal to the area of a sector, of which the radius is the same as the length of the instrument (indicated by l in Fig. 1), and in which the angle between the sides is equal to the angular change in location between the two positions of the instrument.

The value of the area, however, may be positive or negative. If, for instance, after the planimeter has reached position $A'\,B'$, it should return to its previous position, $A\,B$, it would have swept over the included area twice, once in a positive direction and again in a negative direction, thus reducing the value of the area to zero. We may then say that the area swept by the instrument may be given a positive valuation when the angular movement is in the direction of the hands of the clock; while, if the angular movement is in the opposite direction, the surface generated may be considered in a negative sense.

Now, let us look at Fig. 3 and analyze the action of the instrument in obtaining the area of the figure $A\,F\,A'\,C$. Starting with the stylus point at C and going around the outline in the direction of the arrows, the hatchet and the instrument will trace the curve $D\,B\,B'\,D'$. When the stylus is at C, the hatchet will be at D; when the stylus is at A, the hatchet will be at B; when the stylus is at F, the hatchet will be at E; when the stylus is at A', the hatchet will be at B'; when the stylus is at C again, the hatchet will be at D'. Then $C\,D = C\,D' = l$ = the length of the instrument. There are in this traced curve two points, $B\,B'$, where the outline takes a sharp retrograde direction. These points of retrogression will take place when the instrument is in a position normal to the curve it is tracing; in the case of simple outlines, there will generally be two of these points, as is the case in Fig. 3.

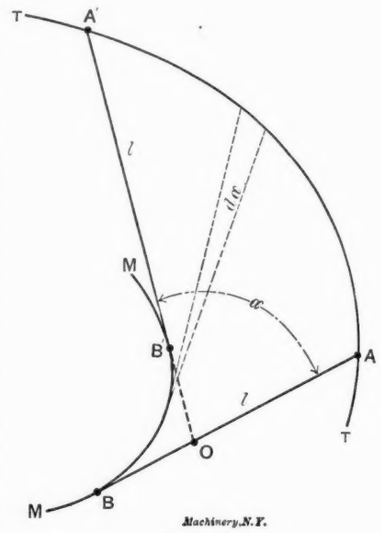


Fig. 2.

Now, in moving from C to F the instrument sweeps over the area included between curves $C\,A\,F$ and $D\,B\,E$, and the two radii $C\,D$ and $E\,F$. In going from F through A' to C again, the instrument sweeps over the area included between the curves $F\,A'\,C$ and $E\,B'\,D'$, and the two radii $E\,F$ and $C\,D'$. In the first half of the movement, the area swept over may be considered as negative. The second part of the movement from F through A' to C will generate a surface whose area has a positive value, as previously explained, since here the angular movement of the instrument is in the direction of the hands of a clock. Different portions of the area swept over by the instrument are shaded in different ways to represent the direction of rotation of the instrument and the number of times that the arm of the instrument passes that particular area. For convenience in investigating the operation, in Fig. 4 outlines are given of the various fragmentary areas which go to make up the main figure. These fragmentary areas are represented by S_1, S_2, S_3, S_4, and P, and these letters will be used to designate these areas, in finding a formula which will describe the action of the instrument. Referring to Figs. 3 and 4, by inspection we may perceive that the following expression is true:

$$P = S_3 + S_2 - S_4 - S_1. \qquad (1)$$

Let us for the time being assume that S_1 equals S_2. If this is the case, they will cancel in the preceding expression, giving us as a result

$$P = S_3 - S_4. \qquad (2)$$

If we start at C to trace the outline $C\,A\,F\,A'$ the final position of the instrument will be on the line $C\,D'$. If we swing the instrument around point C, bringing the hatchet end from point D' down to D, which was its original position, according to the analysis made in the first paragraphs, the total area swept over by the instrument will be zero, since the instrument lies in the same straight line with its starting position; the angle between its two positions will be zero, making the area swept over also zero. In expressing the complete cycle of movements as a formula, it will obviously not be necessary to include that part of the operation which involves the pass-

ing over of an area twice, if it is done at one time in a positive and at the other time in a negative direction; the two values will undoubtedly cancel each other. It will be noticed that at one place there is a small space which has been passed over three times, once in a negative and twice in a positive direction. This cancels out and gives us the equivalent of an area passed over once in a positive direction. Bearing these points in mind we may add together all the areas swept over in tracing the curve, and then swinging the instrument from $C\,D'$ back to $C\,D$ again, thus:

$$S_3 - S_3 - P + S = 0. \qquad (3)$$

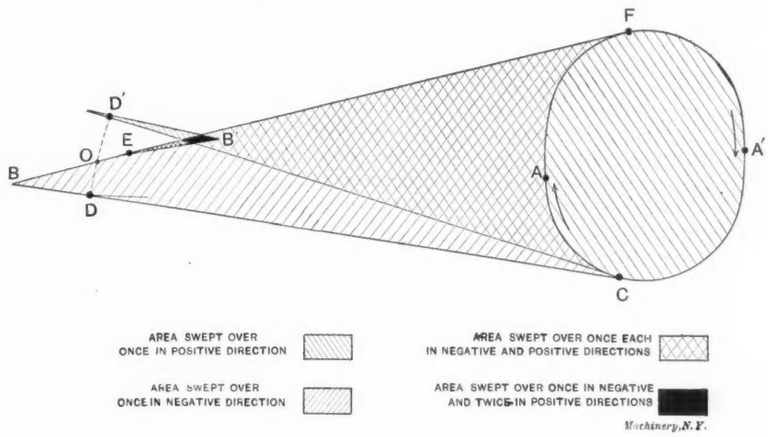


Fig. 3.

P represents, of course, the action of returning the instrument to its initial position, an action necessary to complete the proof, but not necessary in the actual measuring of the area of the desired outline. By assuming that S_1 equals S_2, in the preceding paragraph we proved that $P = S_3 - S_4$. Substituting this value in formula (3) we have the expression:

$$S - P - P = 0 \quad \text{or} \quad S = 2\,P. \qquad (4)$$

That is to say, the area which we desire to measure is equal to twice the area included between the initial and terminal positions of the planimeter. This area is in the form of a sector of a circle and the area of a sector of a circle is equal to the radius multiplied by half the length of the arc. In this case the area of P will be equal to $l \times \frac{1}{2}\,D\,D'$. Substituting this value for P in formula (4), we have:

$$S = l \times D\,D'. \qquad (5)$$

The length of the instrument, l, is a constant quantity, and for measurements in English inches may well be made 10 inches long. If, then, we measure the distance between D and D' and multiply it by 10 this will give us the value in square inches of the area we desire to measure.

It will be remembered that we made the assumption that $S_1 = S_2$. In order that this assumption may be realized, a condition which is necessary for the correct working of the instrument, we must start the tracing of the outline, or in other words, locate C, in such a position that arc $D\ D'$ will cut across curve $D\ B\ B'\ D'$ in such a way as to make these two triangles, $D\ B\ O$ and $O\ B'\ D'$ or S_1 and S_2 as we have called them, equal. In general, they will be practically equal when the instrument is started in such a position that a normal to the curve at the starting point will pass through the center of gravity of the area. By observing the nature of the curve $D\,B\,B'\,D'$ it will be seen that considerable variation may be allowed in the location of point C without sensibly affecting the length of arc $D\,D'$, which is the measure of the desired area.

M. Flamant, who wrote the article in the *Revue de Mecanique* referred to above, says in relation to the best method of using the instrument: "The operation of measuring the area of a surface is so simple that it is advisable to do it a second time in each case, especially if the operator has not acquired considerable facility in the use of the instrument. To do this the figure may be turned half-way around and the tracing started from a point diametrically opposite to the first, or else, which amounts to the same thing, one may start from the same point but work with the hatchet end at the right hand instead of at the left. The mean of the results of the two operations may be used if they agree closely enough with each other. If there is considerable variation between them, one of the two at least is wrong."

Referring to the method which was illustrated in our September issue he says: "By a complicated calculation, on the whole rather barren of results, it can be demonstrated that if instead of starting the tracing from a point in the outline, as we have supposed, the tracing be started from the center of gravity of the area which we wish to measure, then by following a definite line to a point on the contour, the tracing point be carried around the outline and returned to the center of gravity again, following the same line in a contrary direction, then the condition necessary to make the areas S_1 and S_2 equal to each other is apparently realized. In reality the result is only approximate and is scarcely more exact than that obtained by starting the tracing from a point judged by the eye as before explained, so I am led to put this method on record without recommending the use of this supposed refinement."

* * *

One of the old questions asked to puzzle would-be scientists is "What becomes of the energy of a coiled spring that is dissolved in a bath of acid?" Evidently this question was entirely hypothetical for it appears to be practically impossible to dissolve a spring under tension in acid for almost as soon as the acid touches a spring in such condition it cracks and breaks. The cause of this phenomenon appears to be the absorption of hydrogen generated by the acid reaction which makes the steel very brittle. Steel has great affinity of hydrogen, especially when hot, and this is oftentimes the cause of its deterioration when worked. It has been found that steel at red heat will occlude 20 times its volume of hydrogen, according to a statement made by Mr. Maunsel White of the Bethlehem Steel Co. The hydrogen gas is not in chemical union and can be driven off by heat. Steel wire after pickling becomes very brittle but if heated to a cherry red and annealed the hydrogen is driven off and it becomes ductile again.

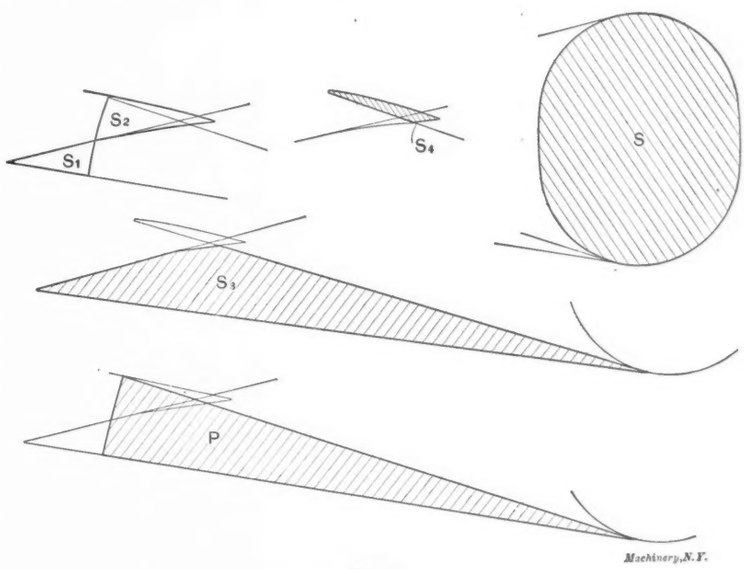


Fig. 4.

SOMETHING ABOUT THE MANUFACTURE OF BELLS.

Some months ago the writer had the pleasure of visiting the well-known bell foundry of Meneely & Co., West Troy, N. Y. This concern was established in 1826, and, therefore, has a manufaturing history of sixty years, a span of time that few concerns in this country can boast of. Mr. F. P. Lotz, the superintendent, who it will be remembered wrote an interesting article for MACHINERY, February, 1905, on the manufacture of bells, says that the standard bell metal is copper 78, tin 22, or copper 77, tin 23. Silver was never used in the manufacture of bells, although the impression that such was the case was carefully cultivated in ancient, and even in modern times. Mr. Lotz showed the writer how the silver was (not) used when, with certain appropriate religious ceremonies, it was supposed to be mixed with the bell metal. It was simply thrown into the firebox of the reverberatory type of furnace, which has for many years been used for melting bell metal, and the fire was industriously poked so that the silver coins soon fell through the grate bars into the ash-pit. Needless to say, they were removed and pocketed by the bell founder and his assistants after the heat was taken off, while the good people went home in exaltation of mind over their generous and sanctified gift to the church.

Bells are cast as nearly as possible to the exact shape required, and no machining is done on them save the polishing, which is done in a primitive lathe. Sometimes in order to make some of the bells of a set of chimes of the correct pitch it will be necessary to sharpen the edge of the mouth a certain degree, but this is done by a polishing and scraping process rather than by the use of the lathe tools. Bell metal assumes a certain crystalline structure with reference to the exterior surface, and if that exterior surface is removed to any considerable depth the tonal character of the bell is likely to be entirely changed and ruined, for the artistic ear at least. Bell metal is almost universally melted in air or reverberatory furnaces, this being a furnace, of course, having a firebox at one end and the chimney at the other with a chamber between in which the crucibles containing the bell metal are set. A door in the side is provided for giving access to the melting chamber. Over this is a reverberatory arch which deflects the heat downward in its passage from the firebox to the chimney and heats the crucibles. With this construction in mind, the joke of putting the silver coins and trinkets into the firebox can be better appreciated.

The secrets of bell making, if there are any, are the methods of determining the bell contour, and not in the mixtures. Most makers of prominence have their own methods for determining the shape of a bell for a certain size and tone; these methods are usually graphical, although the size of the bell is determined mathematically for the note desired.

* * *

CRAB COUPLINGS.

The simple "crab" couplings are quite commonly used in mill construction and in the rougher and heavier forms of machinery. A correspondent has sent in a blueprinted table giving the dimensions of various sizes of this device to fit shafts ranging from 1 to 7 inches in diameter. This table will be found in the data sheet sent with this month, together with a figured sketch to show the design of the coupling and locate the dimensions. The way in which the parts increase in size as they are applied to larger shafts illustrates a point that will be noted by any one who has to design a series of machines or fittings of different sizes made in the same general design. It is not possible, as one might imagine who has never tried it, to make the coupling for two-inch shaft one-half the size of a four-inch shaft, keeping the ratio of ½ to 1 throughout each of the dimensions. The two-inch coupling, if made in this way, will be found to look out of proportion and will apparently be considerably weaker for the work it has to do than is its prototype. This phenomenon is probably largely a mental one and is perhaps due to an instinctive knowledge on the part of the designer that a given defect or irregularity in the castings or other parts of the smaller mechanism will reduce its effective strength proportionately more than it will in the case of the larger size. Aside from this point, the accidental stresses and overloads to which any mechanism may be subjected, are liable to be greater in proportion to the ultimate strength of the parts in the case of the smaller sizes. To allow for these considerations, and to satisfy the designer's sense of the fitness of things, the unit of measurement used for this line of crab couplings is not the diameter, or a fraction of the diameter, but instead a fraction of the diameter plus a constant quantity. From this unit all the proportions of the clutch except those which must be determined directly from the diameter of the shaft are calculated. As given in the data sheet this unit is given under the column marked δ and is equal to $\frac{D}{3}+\frac{1}{4}$ inch. All the quantities on the sketch not otherwise marked, are decimals and multiples of this unit. All these various decimals and multiples are figured out and given in the table. It will be noticed that where the ends of the two shafts come together a recess of ½ the diameter of the shaft has been bored in one, into which projects a corresponding plug from the end of the other shaft. This is to prevent the lateral deflection of the shaft which would result from using, to transmit a heavy torsional pressure, a clutch whose claws did not bear together evenly.

On the two remaining data sheets are given diagrams furnished by the president of an engine-building concern. These diagrams describe the practice of the firm in proportioning the arms of pulleys; their use will be readily understood without much explanation. For instance, on the eight-arm diagram, if it be desired to determine the size of the arms for a pulley 15 feet in diameter and 36 inches face, the horizontal line marked 36 at the right of the diagram where the width of the wheel is given is followed on until it intersects with the curve marked 180 which stands for 180 inches or 15 feet, the diameter of the wheel. From this point of intersection the width line is followed down to read the graduation at the bottom of the diagram. This vertical line corresponds to 7⅜ inches, which should be the width of the arm at the center of the wheel. A circle of this diameter may be drawn at the center of the wheel, and two tangent lines drawn from it on opposite sides, tapering together at the rate of ⅜ of an inch to the foot, will give the proper width for the arms of an 8-arm pulley of this size. The thickness should be one-half the width. The 6-arm diagram is similarly read.

* * *

A recent issue of *The Foundry* contains a communication "The Foundry is no Place for Girls," which expresses sentiments that exactly coincide with our own views on the subject and which we would commend to the careful attention of every foundryman who is thinking of using female labor for coremaking and other light foundry work. That such work is degrading to womankind can scarcely be questioned, but if there is any doubt it has only to be seen once to be thoroughly convinced that it is a fact. The letter was written after a visit in company with a party of mechanical engineers to one of the largest industrial establishments in the vicinity of New York City. The layout and equipment of this plant attracted universal admiration except for the one feature in the foundry where a large number of girls and women (some foreigners) are employed in making cores. It is hard enough for a man to work ten hours in an atmosphere of gas and dust at labor that soils his hands and clothes to such an extent that any pretense at neatness is impossible; when he goes home, however, he enters another world that seems all the better for the contrast. But if the women who make the homes are brought into immediate contact with the brutalizing conditions of foundry work what will the homes become?

* * *

A little scheme that is sometimes used to prevent the bruising of machine screw heads which of necessity must be made with a slot and which have to be frequently adjusted, is to drill a hole slightly larger than the width of the slot in the center of the screw to a somewhat greater depth than the screw slot. The screwdriver is made with a peg turned on the end which fits into this hole and so keeps it centered and square with the slot.

PRESS TOOLS FOR MAKING A SEAMLESS COVER.

W. VAN ORMAN.

The following describes a set of tools for making a one-piece or seamless can cover which is done in two operations. While this work is not new I suppose there are others, who like myself, have often wondered how this work is done; I did not know until I had occasion to make the set of tools for this particular job, and although I do not know what methods other people employ I will try to give the readers of MACHINERY an idea of the construction used. But before proceeding to describe the working of these tools I would like to say a few words in regard to making these covers in one piece and

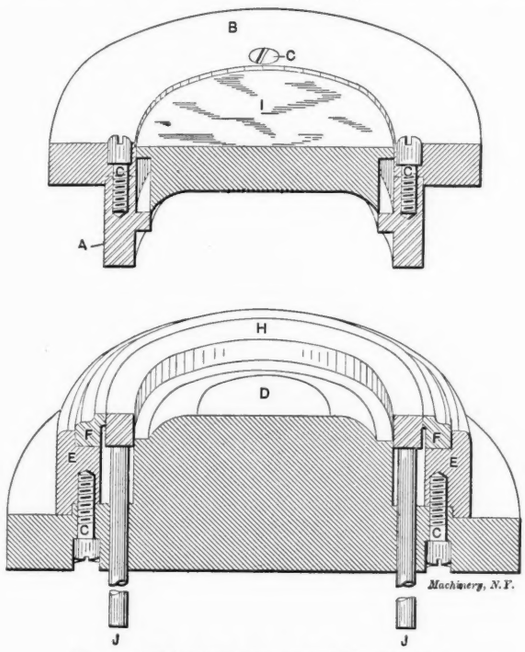


Fig. 1. Combination Forming and Blanking Die.

the cost of a two-piece cover, for the benefit of those who are not familiar with this class of work; I will first give an idea of the work on a two-piece cover.

A two-piece cover is one in which the rim is cut separate, soldered together and afterward burred in by hand. Now,

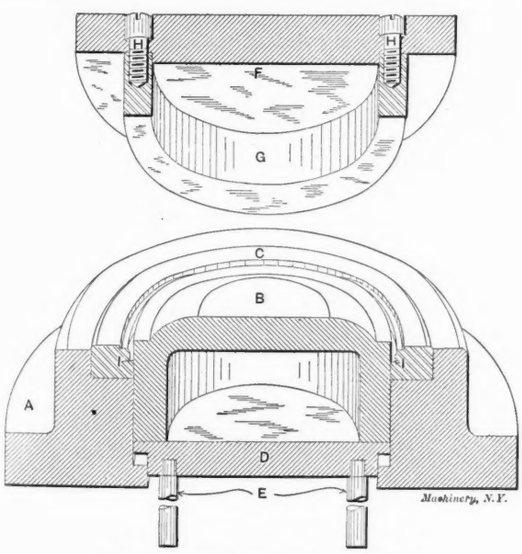


Fig. 2. Second Operation Punch and Die.

these covers had been made ever since I was employed by the company at a cost of $7.70 per thousand for the labor, to say nothing of the cost of the gas required to heat the irons or the solder required to fasten the rims together. The improved press tools which make the covers in one piece have reduced the cost to $2.30 per thousand, and now every cover is just alike.

Figs. 1 and 2 show the first and second operation dies and Fig. 3 shows the trimmer; Figs. 4, 5 and 6 show the cover after the first and second operations, and the trimming operation. Fig. 4 shows it as it comes from the die; Fig. 6 after it leaves the second operation die, in the finished state.

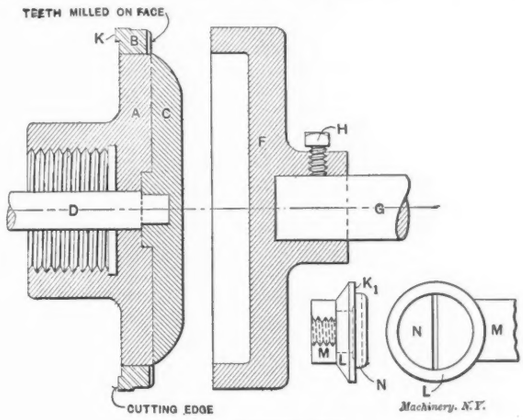


Fig. 3 Trimming Dies.

The trimming operation follows the first operation, being performed on a turret lathe as will be described later on.

The first operation tool is a combination forming and blanking die and is of composite construction. The forming punch, *A*, is made of tool steel and since it only cuts tin it is left soft. It is fastened to the cast iron piece, *B*, by means of the fillister screw, *C*, and the piece, *B*, is countersunk for about ⅛ inch to receive the punch, *A*. The punch is made a nice easy driving fit in *B* so there is no chance for it to shift position, and this construction makes doweling unnecessary. *D* is the forming plug made of cast iron turned to the required shape. *E* is also of cast iron and this part holds the cutting die, *F*. The same construction is employed as in the punch, the ring *E* being fitted closely over a turned shoulder and secured with the fillister head screws, *C*. The cutting die, *F*, is hardened and drawn to a dark straw color, and after being driven into the ring *E* it is ground to size. *H* is a cushion ring and strip-

Fig. 4. Work as it leaves the First Die.

per combined and is made of machine steel. When the ram of the press descends the blank is cut by the punch, *A*, and is held between the punch and the cushion ring until it is formed up. On the up stroke of the press the piece is stripped from the plug by *H*, and the kicker or knockout, *I*. The knockout is a piece of cast iron formed to the shape of the cover, and is worked by a rod running down through the ram of the press. There are six cushion pins, *J*, which extend through the bolster plate and come in contact with the cushion plate. After the die has been set the cushion ring, *H*, is then put into place so that it rests on top of the cushion pins. There are two finger gages on each die which are not shown, also two holes are drilled through the ring *E* for the purpose of driving the ring out when required.

All the parts of this die which come in contact with the metal are polished smooth and bright so that there shall be

no tool marks showing on the piece formed. The smooth finish allows that the metal be drawn more freely. Vent holes are provided of course for the escape of air. In the use of this die I found that a little tallow used occasionally is a great help as it allows the metal to slide more freely between the punch and cushion ring.

The second operation die is not so complicated as the first but is the one that gave me the most trouble. The body of the die, *A*, is of cast iron and bored out to the size of the inside rim of the cover. The cast iron plug, *B*, was turned to the shape shown and was made a close working fit in *A*. The tool steel ring, *C*, was made a driving fit in *A*, and is two

Fig. 5. After the Completion of the Second Operation.

thicknesses of metal larger than the plug *B* for 3/8 inch in depth. The upper half of the die, *F*, which is cast iron, is fastened to the ram and the steel ring, *G*, is secured to it by the fillister head screws, *H*. The ring, *C*, is counterbored about 1/8 inch deep, and the punch is made the same size as the counterbore to make it easy in setting the die.

After the covers have been trimmed they are placed upon *B* and as the ram of the press descends it forces the plug, *D*, down and the outside edges of the cover come in contact with the shoulder, *I*, which forces the metal to turn upward, for there is no other place for it to go. The mouth of ring *C* is belled just enough to make sure of the cover entering each time. This completes the one-piece cover.

Fig. 6. The Finished Work.

It may be of some interest to relate a few of the troubles which I had with the second operation in getting it to work to my satisfaction and produce a perfect cover. Since it was a hinge cover the rim was made only 3/8 inch high whereas if it had been intended to be a removable cover to fit a pail or something similar it should have been 1/2 or 5/8 inch high. The principal feature to mention, however, is the difficulty experienced in upsetting the metal so as to form the flange which keeps the cover from dropping down in. The trimming must be done exactly right. If there is too much metal, the straight part which fits the pail will be buckled and the flange will be distorted. If, on the other hand, there is not enough metal the flange will not be fully formed. This cover was trimmed so that the lip measured 11/16 inch and this amount formed a nice smooth rim 3/8 inch high and a flange 5/32 inch wide all around.

As we had no trimmer for trimming the covers after the first operation one was made which is shown in Fig. 3. *A* is a piece of cast iron threaded to fit the spindle of a monitor lathe and *B* is a tool steel ring that is cut on the face something after the fashion of a milling machine cutter; this part is made a driving fit on *A* and is hardened and drawn to a dark straw color. After having been driven on to *A* it is ground on the face so as to run true. *H* is a piece of cast iron which acts as a holder while the covers are being trimmed and *G* is a piece of machine steel on which it is mounted for holding in the turret head of the lathe. *C* acts as a kicker or knock-out, being worked by rod *D* which runs through the hollow spindle of the machine. The tool for trimming is shown in the same view. The shank, *M*, fits in the toolpost in the cross slide and the revolving cutter, *L*, is a piece of tool steel turned to shape, hardened and ground. It acts by shearing off the metal between the edge *K* on *B* and K_1 on the cutter; it makes a nice clean job, square and accurate, and is rapid in use.

* * *

THE ADVANCE IN THE PRICES OF MACHINE TOOLS.

As reported elsewhere in this paper, the builders of lathes, planers, shapers and upright drills, who are members of the National Machine Tool Builders' Association, have advanced the prices of their products by amounts varying from five to ten per cent. Advances in other lines are quite likely to follow. Letters were sent out from this office to a number of the firms concerned in the movement, asking for definite information as to the causes of this advance. The answers received present quite clearly the builders' side of the question, giving definite figures, in most instances, to uphold the contention that the advance does no more than cover the increase in the cost of production during the period since prices were last determined. The following extracts will illustrate the general tenor of the replies:

"During the past six years cast iron has advanced, with us, 10 per cent. We are paying about the same wages as in 1901, but more than in 1903 or 1904. We are now paying about 5 per cent more than six or eight months ago. The cost of cast iron and labor each constitute about one-third the value of our product. Hence, if we have to pay 10 per cent advance on material (one-third the value of our product) and 5 per cent advance on wages (one-third the value of our product), it means that about five per cent should be added to the price of our product to cover the advance in cost of manufacture."

"If there had been absolutely no advance in material the general growth and improvement of machine tools would justify the recent advance in price. The lathe or milling machine of to-day is no more like one made five or six years ago than a fine Swiss watch is like an Ingersoll. Five years ago practically all the detail parts of machine tools were made of cast iron. To-day these are all made of steel. Where belt feeds and small light feed belts were formerly used, intricate gear feeds and much heavier driving construction is used on all machine tools. For instance, a No. 2 miller will weigh more, pull a heavier cut, can be handled quicker and do more work than a No. 3 machine would as manufactured five or six years ago. This same illustration will hold good of practically all machine tools. The only trouble with the Machine Tool Builders' Association is that they have not kept their prices in line with the added improvements of the tools to say nothing of the increased cost of material and labor. Five years ago we were all working on a 60-hour basis; to-day we are working on a 55-hour basis. This single item, not considering any other, is equivalent to a 12 per cent additional cost, because it has not only increased the cost per hour, but the general expense has to be divided among fewer productive hours."

"We give below the increased cost of labor and material during the past year, which has been more than sufficient to justify all advances made by manufacturers:"

	Per Cent.		Per Cent.
Labor	5 to 10	Composition castings	35
Castings	10	Machine screws	25
Machinery steel	20	Drop forged wrenches	10
Babbitt	70	Lumber	20

"To justify the recent advance in price, it will be necessary only to refer to the advances in costs to us during the same period. Labor has advanced very materially and we find the cost of the following items has increased as set forth:"

	Per Cent.		Per Cent.
Steel forgings	20	Cast iron	7½
Bar steel	10	Cast steel	4
Screws	30	Motors	5
Nuts	5	Lumber	28
Coal	8		

"There are many causes for a rise in the price of machine tools, the most important being the increased price of both labor and material. Cast iron is at a very high figure at the present time, and labor is getting more for its services than ever before. Bar steel, brass and all other materials entering into the construction of machine tools are higher than they have ever been. Another feature, and by no means the least important, is the cost of alterations, new patterns, etc., which have become necessary during the past four or five years, in order to meet the demands put upon tools by the new high-speed steels. The tools, as built to-day, are no more like those which manufacturers were building five or six years ago than they were at that time like the old-fashioned chain lathe and screw planer. Purchasers of machine tools have not taken into consideration the tremendous cost to the manufacturers of all these changes. They expect that machine tool builders can furnish machines weighing anywhere from 33 1-3 to 200 per cent more than formerly without any extra cost for the tool. Incidental to this is the enormous expense of making patterns, drawings, jigs, and new tools, for none of which did the machine tool builders receive sufficient remuneration. Furthermore, they would submit tools to any strain which they might desire and if the tools did not stand up to the work, it was the fault of the tool and the expense of the repairs and alterations must all be borne by the manufacturer. The machine tool business requires a larger investment of capital than any other line of business of which we are familiar, and yet the dividends of machine tool builders have never been what could be termed more than fair.

* * *

THE BLUFF THAT GOT CALLED.

We had a new plater come in lately to take charge of the finishing room. He is an old fellow and his hair is white, but he is all there; he has been around a good deal and seen things. We both carry our lunch (for that matter the whole shop does) and the other noon-time he got "chummy" and told me a lot of things—where he had worked; what he had done, and things he had run up against, but the best thing he told me was his experience with aluminum work.

The man looked kind of queer.

He had taken charge of the polishing room in a big bicycle factory, and as it was a good berth, he was very anxious to make good. Things went on all right for a week or so, and he was getting so he felt solid. Every lot of work that came into the room had a tag on it—a "work tag," as it was called—telling just what was to be done on that lot of work. One day a pan full of aluminum work came in, saying on the tag: "Polish and plate." Now aluminum was a new metal in those days, and though Frank had polished a little of it, he didn't know the darn stuff wouldn't plate worth a cent. It went through the finishing room all right, and when it came to the plating room, Frank said to the man: "Wash it up well and put it in the white metal bath." The man looked at Frank kind of queer, but it's a good man that does as he is told, and into the bath it went. Frank run it an hour or two, then took a look at it. Not a plate. He put on the current a while longer, then looked again with the same result. He tried his hydrometer in the bath, but it was all right, then he went to the man and blew him up for not having washed it clean; told him to take it out and put it into the potash, and then into the bath again. The man said not a word, did as he was told and put it in the bath again. He ran it several hours, but not a plate. By this time Frank was getting the cold chills down his back and was feeling pretty desperate, and as Frank said: "It was right here that I made the break."

"Don't you know that aluminum can't be plated."

He had just got hold of a circular of a new plating salts guaranteed to plate anything, and grabbing the circular, and one of the aluminum castings, he bolted into the superintendent's office. The old man was in and Frank "broke his egg."

"I am having a little trouble plating these aluminum castings, and you will have to get me a lot of these salts, about five pounds will do, I guess." The old man looked at Frank, then at the aluminum, and then back to Frank. "You darn fool," he blurted out, "Don't you know that aluminum can't be plated? I thought you were a good man, and I had got a prize, but I think you are a d——n bluff. Go to the paymaster and tell him to pay you off up to the end of the week; never mind about working out your notice. You will be trying to plate the dynamo next."

"I didn't say a word," said Frank, "but it was the first and only bluff I ever tried to put up, and it learned me a lesson and that was: 'To keep away from the superintendent's office unless I was sure of my ground, or was sent for, and had to go.'"

Frank has made a good many attempts to plate aluminum since that time, and he gave me a receipt that would come nearest to depositing a plate on aluminum of anything he had ever found. The five-minute whistle blew and we filed in past the clock, but I could not forget "the bluff that got called."

A. P. Press.

* * *

Oil squirt guns, air pumps, etc., which have no leather packing, are now being manufactured for automobile use. The brass pistons are accurately ground to fit drawn brass cylinders so closely as to be air-tight and yet work freely. This construction is advantageous as a pump so made wears a long time without leakage. A squirt gun made with leather packing is quickly rendered useless when used with gasoline, for gasoline rots leather. The same construction is being employed for handling certain chemical solutions which do not affect brass, but which quickly destroy any vegetable or animal substance used for packing.

CHATTANOOGA MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers held at Chattanooga, Tenn., May 1 to 4, was in several respects an unusually successful convention. The attendance was small, since there is not a large membership of the A. S. M. E. in the South and Chattanooga itself is not near the center of engineering interests in this country. Chattanooga as a meeting place has scenic and historic advantages second to no other city and the attending members and guests found the four or five days of the convention altogether too short for the excursions planned by the local committee, to say nothing of the time required for the professional sessions, which, as a matter of course, ought to be the leading feature, but unfortunately seldom are at the spring meeting.

At the first professional session on May 2 the several business items on the calendar were attended to. These included the report on the election of members; a report on the Carnegie building for the engineering societies in New York, stating that the steel frame of the structure is already completed and the walls are complete up to the thirteenth floor; and the reports of the standing committees. Notice was given of proposed changes in the constitution and by-laws relating to details incident to the expenditures of the society; provisions for the appointment by the council of an honorary secretary; and the establishment of a permanent research committee having a membership changed by rotation, one member being elected and one retiring each year.

The papers presented, taken as a whole, were of high technical merit. It has lately been the custom to have some one subject predominate at the different sessions and a collection of papers presented to cover different phases of this subject. At this meeting Water Wheel Governing was the topic and was discussed in the following five papers: "Some Stepping Stones in the Development of a Modern Water Wheel," by Mark A. Replogle; "Regulation of High-Pressure Water Wheels for Power Transmission Plants," by George J. Henry, Jr.; "Speed Regulation of Water-Power Plants," by John Sturgess; "Turbine Design as Modified for Close Regulation," by George A. Buvinger, and "Efficiency Tests of Turbine Water Wheels," by William O. Webber.

In view of the remarkable development of water-power generating plants since electric generators and distributing systems have attained to their present state of development, the question of speed regulation of such plants a most important one. The difficulties to be overcome in their speed regulation are enormous, owing to the inertia of the water tending to produce momentarily an effect opposite to that desired when the turbine gate is opened or closed. This is explained in a simple manner in the paper by Mr. Sturgess in the following words:

"The ultimate function of the gate is to control the power output of the wheel. It does so (or attempts to) by varying the aperture through which the water flows. It may appear at first sight that this means would directly accomplish the purpose, but a little consideration will show that it will not do so in the manner required under modern conditions.

"The gate consists, essentially, of an adjustable aperture, as stated above. It is set so that the water passes immediately from the aperture into the wheel, this remark applying alike to cylinder, register, wicket and other forms of gates as found on water wheels of the present day. Reducing the aperture (closing the gate) is intended to reduce the power output of the wheel, and increasing the aperture (opening the gate) is intended to increase the power output.

"It will, however, be obvious that simply *increasing* or *decreasing* the aperture will not cause the power developed by the wheel to vary in like manner for the reason that any sudden restriction in the aperture cannot instantly check the velocity of the mass of moving water extending throughout the whole hydraulic system. The immediate effect of reducing the aperture is to cause the *same mass* of water to be ejected on the wheel, but with a *higher velocity*, thus actually increasing the power of the wheel at the very moment when uniformity of speed demanded that it should be decreased. On suddenly increasing the aperture, the reverse effect takes place."

Next in interest to these several papers upon water wheel governing, but first in importance, is the paper upon the collapsing pressures of Bessemer steel lap-welded tubes, 3 to 10 inches in diameter, by Prof. Reid T. Stewart. This paper is abstracted in the Engineering Edition this month and contains the most complete and reliable information ever presented on this subject. In fact, these tests show that previous formulas for collapsing pressures upon which engineers have placed their reliance are entirely erroneous under the present state of the art. It is seldom that the society is able to place upon its records the results of so comprehensive a series of tests as were made by Prof. Stewart at the instigation of the National Tube Co.

Two important committee reports were submitted: one upon standard proportions for machine screws and one upon the Pennsylvania Railroad locomotive tests conducted at the Louisiana Purchase Exposition. The recommendations of the committee upon machine screw proportions are to come up for further discussion at the next annual meeting, and so are not final, but we publish an abstract of their report in another part of the paper, since this subject is one in which all machine shop readers will be interested and we should like to give those subscribers to MACHINERY who do not have the proceedings of the A. S. M. E. an opportunity to judge for themselves of the work of standardization that has already been accomplished.

The report upon locomotive tests was by the committee appointed by the society to co-operate with the Pennsylvania Railroad, and a similar committee appointed by the Master Mechanics' Association, in conducting tests at the locomotive testing plant installed by the Pennsylvania Railroad at the Louisiana Purchase Exposition. Eight locomotives were tested during the exposition and results of these tests have been recorded with great elaboration and detail in a large volume issued by the Pennsylvania Railroad. The report of the committee submitted at the Chattanooga meeting summarized the most important results and is a valuable contribution upon the subject of locomotive performance.

Two of the papers presented had previously been given at the local meetings of the society held during the past winter at New York City. These were "Low-Resistance Thermo-electric Pyrometer and Compensator," by Prof. Wm. H. Bristol, and "A History of the Introduction of a System of Shop Management," by James M. Dodge. These papers have already been noticed in previous numbers of MACHINERY and it need only be said that Prof. Bristol has undoubtedly succeeded in producing a pyrometer simple in construction and inexpensive to maintain, which can be used successfully in commercial work. Not only is this of great importance in strictly metallurgical operations, but it should serve a most useful purpose in the treatment of high-speed steel in machine shops. Other papers were "The Effect of a Blow," by Alexander W. Mosely and John Lord Bacon; "A New Liquid Measuring Apparatus," by Geo. B. Willcox, and "The Improvement of the Tennessee River Power Co. at Hale's Bar, Tenn.," by Thos. E. Murray.

The first of these, which is of the greatest interest to machine shop readers, proposes a plan for rating steam and power hammers by using a standard plug to measure the effect of a blow. Plugs of Bessemer steel rods were used in the experiments outlined. When erected on the center of the anvil the hammer was allowed to fall freely from a given point. Knowing this weight and the distance through which it fell its kinetic energy could be determined and the compression of the plug gave a means for finding the force of the blow. From these data the loss of energy in the hammer could be determined.

* * *

During the Master Car Builders' and Master Mechanics conventions to be held at Atlantic City, June 13 to 20, the Niles-Bement-Pond Company will have on exhibition and in full operation one of their extra heavy 90-inch driving wheel chucking lathes. This will afford an exceptional opportunity to observe this machine at work. Owing to its great weight, this machine cannot be shown on the steel pier. They have therefore built a special booth two minutes' walk south from the Pennsylvania R. R. station on New York Avenue, near Atlantic Avenue, where all are cordially invited to witness a demonstration of this machine.

LETTERS UPON PRACTICAL SUBJECTS.

SHOP VISITORS—ROLLING IN BABBITT—PLANER TOOL LIFTER.

I enclose a few photographs that may interest some of your readers. Fig. 1 shows a "pass card," used by one of the largest firms in the country in their special line. The card serves as a pass through their works, and also as a permanent record of their visiting friends. It is the standard 3 x 5-inch size,

(*Name*)_____

(*Address*)_____

PASS THE BEARER

Upon this date only, through the works of the

B. F. STURTEVANT CO.

Hyde Park, Mass.

The visitor accepting this pass agrees to keep the same in sight, to *return it to the office* upon leaving the works, not to talk to the workmen, and to hold this Company blameless on account of damage to clothing or of personal injury.

_____ *190* O _____

Fig. 1. Pass-card used at the Sturtevant Shops.

and appeals to me as the neatest method of several that I have seen, and is in direct line with the present tendencies of office records.

Many of your readers have visited the works of the Brown & Sharpe Mfg. Co., Providence, R. I., were asked to register, and are familiar with the "big book." In my case this has happened several times, and always the thought has come: what an interesting hour could be spent looking over the names in it, some of which are used to conjure by in the mechanical world.

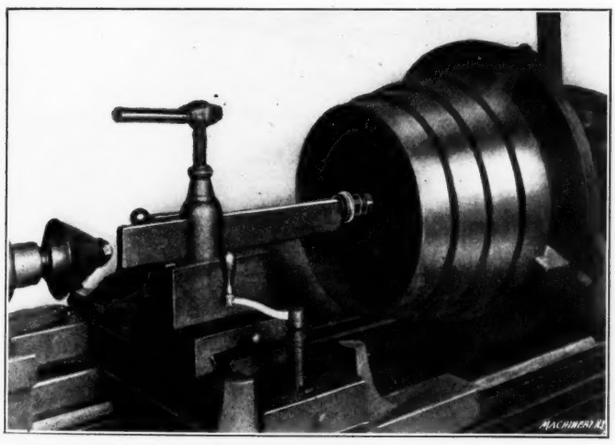


Fig. 2. Rolling Babbitt in a Cone Pulley Bearing.

At the Washburn shops of the Worcester Polytechnic Institute, a register of names has been started, and already contains the signatures of visitors from all parts of the world. It would seem to the writer that every shop should have a register of visiting friends, in view of the fact that almost universally are our shops open to visitors.

Fig. 2 shows a home-made method of rolling the babbitt in a large, loose pulley cone of the design shown in Fig. 3. The babbitted hole was in this case enlarged after babbitting and before boring nearly an eighth of an inch with comparative ease. An old lathe tool with the end forged down, turned and threaded to make a stem on which to mount a roll, is a job that can be done by anyone, and is the tool shown. If many such holes are to be rolled, some sort of an expansion roller mandrel is the tool to use, but in this case none was at hand, and it was not deemed advisable to go to the expense of making so elaborate a tool for a single hole.

In Figs. 4 and 5 is shown a simple device for lifting and supporting the tool during reversal of a planer. This device can be made automatic by arranging the proper connections, but as used on this job is more convenient as shown. The cam is made by forging a piece of flat stock into the shape shown, and smoothing the edges on a grinding wheel. The block, into which the holding bolt screws, is threaded to fit the binder bolts in the clapper, and is afterward split for convenience in attaching.

H. P. FAIRFIELD.

Worcester Polytechnic Institute.

SOME DRAFTSMEN'S AND DESIGNERS' KINKS.

Herewith I submit a few "kinks and things" which have helped me. While these are not new to all, I trust that they will interest a number sufficiently to justify their publication. Some simple problems are at times quite puzzling by reason of the way in which they are presented. Data is not always at hand, and what follows can be easily remembered.

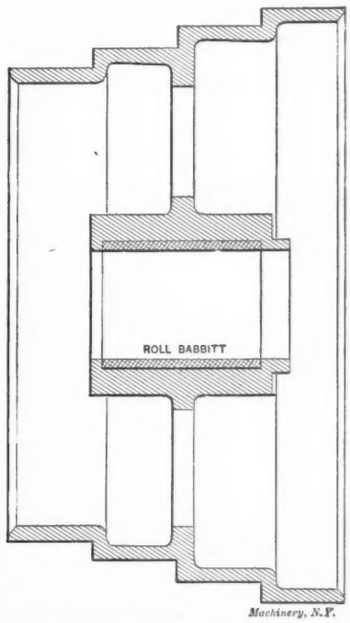


Fig. 3. Section of Pulley shown in Fig. 2.

To find the diameter of gears when the center distance and velocity ratio are fixed: Divide the center distance (in inches) by the sum of the numbers comprising the ratio; multiply this quotient by each of the terms of the ratio. The products thus obtained are the radii in inches of the gear and pinion, and the rest is easy. To illustrate, suppose the center distance = 22.5 inches and the ratio = 0.8 : 0.3, or 0.3 of a revolution of the gear must drive the pinions 0.8 of a revolution. $0.8 + 0.3 = 1.1$, and $22.5 \div 1.1 = 20.4545+$.

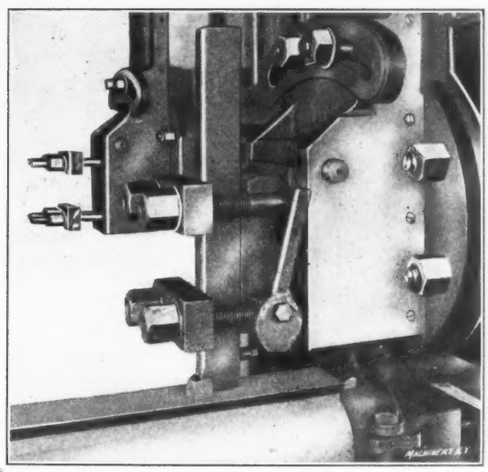


Fig. 4. Tool Lifter in Working Position.

$20.4545 \times 0.8 = 16.3636$ inches = radius of the gear.

$20.4545 \times 0.3 = 6.13635$ inches = radius of the pinion.

$16.3636 + 6.13635 = 22.49995$ inches = the center distance, very nearly.

The number of teeth in the gear and pinion must, of course,

be the exact ratio. If, in the above case, the gear and pinion contain respectively 64 teeth and 24 teeth, the circular pitch is 1.606+ inch.

The ratios 0.8 : 0.3 may be conveniently changed by multiplying both terms by, say, 5, which gives 4 : 1.5, and the result will be the same.

If the sum of the terms equals 1, or if the ratio can be reduced so that the sum of its terms equals 1, it is only necessary to multiply the center distance by each of the terms of the ratio, as, for example:

Center distance = 22.5 inches, and the ratio = 1.5 : 1; then $1.5 \div 2.5 = 0.6$, and $1 \div 2.5 = 0.4$, that is, 0.6 : 0.4 the sum of which is 1. Hence $22.5 \times 0.6 = 13.5$ inches = radius of gear, and $2.25 \times 0.4 = 9$ inches = radius of pinion.

When the center distance and velocity ratios are fixed by some essential construction of a machine, it is usually impossible to use standard diametral pitch gear teeth. If cast gears are to be used it does not matter so much, as a patternmaker can lay out teeth of one pitch as well as another, but if cut gears are required an effort should be made to alter the center distance so that standard cutters can be used.

When designing a pattern from which only one or two castings are to be made, do not go to extremes to save weight in the casting. The extra work required of the patternmaker may cost more than the saving in metal would amount to. If appearances are an important consideration, that, of course, is another matter.

In developing a grooved face cam, first lay down two horizontal lines, the length of which is equal to the circumference of the cam at the bottom of the groove, and the distance apart equal to the width of the cam over all. Divide the lower line into 24 equal parts, and one of these spaces (preferably the one at the left) into 15 parts. Each of the 24 spaces represents 15 degrees and the 15 smaller spaces each represent one degree of the circumference. If the movements are timed by binary or other divisions of a revolution which are not multiples of 360, divide the upper line into as many such parts as are necessary to locate the points where the path changes its course. By projecting lines from these points to the lower line it is easily seen how many degrees each movement and dwell occupies, also the number of degrees from a given point on the circumference to any other point. The keyway may

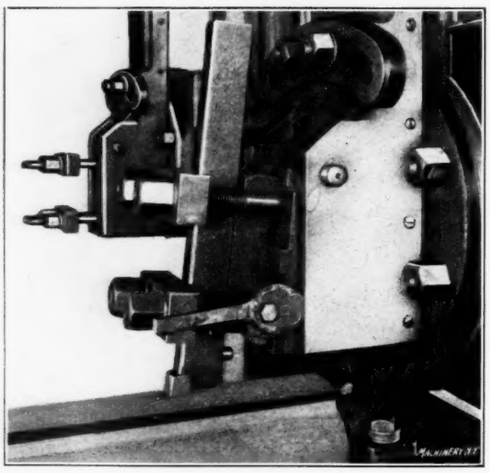


Fig. 5. The Tool Raised.

safely be located, unless for very accurate work. Of course the exact relation of this cam to other cams or gears must be known, and the keyseats in the shaft for related cams and gears should be in line.

When designing a new machine, first know exactly what it has to do; decide upon the order of operations, then make rough sketches of several ways, if possible, of performing each operation. After selecting what seems to be the best way of performing each operation, make assembly sketches showing plan and elevations. This gives a good general idea of the machine without wasting drawing paper, and is much quicker than making drawings to scale. When the movements and general plan of the machine are decided upon, make assembly views to scale. If a complicated machine, make drawings of closely related parts assembled, for this is sometimes of more assistance to the machinist than an assembled view of the whole machine. The framing usually comes last and is made to conform to the necessary construction of the working parts, and should be as symmetrical and free from sharp inside angles as possible.

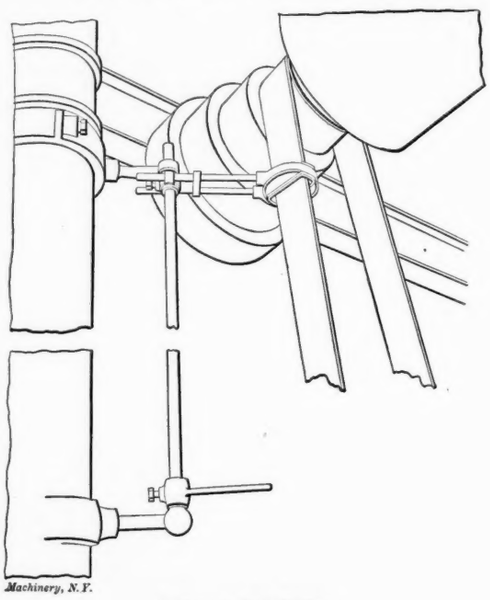
When a tracing is left unfinished on the board over night it takes ink much better the next morning if chalked again before beginning to ink. I use talcum powder, which seems to answer as well as prepared chalk, and it comes in boxes convenient to use.

Whittle a flat spot on the cork of the ink bottle just where your thumb rests when the quill is in position for filling a pen. Then you can always get the right hold on it.

Don't erase ink from tracings until it is thoroughly dry. If it is necessary to do any erasing, leave it until the tracing is finished and dry. By doing this, inking over an erasure is avoided.

HANDYMAN.

A GERMAN BELT SHIFTER.



A German Belt Shifter.

The belt shipper or shifter here shown is made by a German firm and may interest your readers. For convenience of application and ease of action it seems commendable.

Hanover, Germany. ROBERT GRIMSHAW.

MORE DRAFTSMAN'S DON'TS.

The don'ts for draftsmen recently published expressed very well some of my own ideas on the things that a draftsman should learn not to do. Here are some more which I feel should be more generally known by the drafting fraternity:

Don't fail to index a drawing properly so that it can be found readily when wanted.

Don't use too many large words on a drawing, but use plain and simple language in all cases.

Don't make three or four different views of a piece when one or two views will do as well.

Don't ever forget to put the scale on a drawing.

Don't give the same dimension twice, for it is liable to lead to errors when this dimension is changed.

Don't leave some dimensions to be gotten by adding a lot of other dimensions together or by subtracting them; all figuring should be done in the drafting room.

Don't leave out any data that should go on a drawing of a worm gear, bevel gear, etc.

Don't fail to use stock sizes of drills, reamers, etc., when possible.

Don't scrape off dried ink from the inside of a ruling pen with a knife or any hard instrument.

Don't allow any corrosion to take place on the inside of a

ruling pen; it must be polished and lapped out smooth to ink well.

Don't give strange names to the parts of a machine, but in every case strive to name each in a way that shall tell its mission in the machine.

Don't forget to give on the drawing of a collar or pulley the direction it can be reamed or bored from to help assembling.

Don't put on too much fancy shading and lettering on shop drawings, but strive to make good, plain, clear drawings, with plain lettering in all cases.

Don't fail to have all your work checked before it enters the shop.

FRED. G. KENYON.

Providence, R. I.

* * *

TO CALCULATE THE CENTER ANGLES OF A PAIR OF BEVEL GEARS HAVING THEIR AXES AT OTHER THAN RIGHT ANGLES.

Fig. 1 represents the layout of a pair of bevel gears, the angle between their axes being represented by the bevel of x, in 12 inches. In cases where this angle is quite small, the following method of determining the angles AOB and BOC, in terms of the bevels y and z in 12 inches, may be used.

The known quantities assumed in the problem are the angle AOC and the gear radii AB and BC. Designate the radius AB by R, and BC by r. From the point A drop a perpendicular AE to the axis OC, and from B drop a perpendicular, BD, to AE. Then we have:

$$OA = \frac{AE\sqrt{12^2+x^2}}{x} = \left[r + R\frac{12}{\sqrt{12^2+x^2}}\right]\frac{\sqrt{12^2+x^2}}{x}$$

$$= \frac{r\sqrt{12^2+x^2}}{x} + \frac{12R}{x} = \frac{1}{x}\left[r\sqrt{12^2+x^2} + 12R\right]$$

$$\frac{y}{12} = \frac{R}{OA} = \frac{Rx}{r\sqrt{12^2+x_2}+12R}$$

$$\text{Also the slope, } \frac{z}{12} = \frac{rx}{R\sqrt{12^2+x^2}+12r}$$

Having calculated the slopes of the pitch lines, the slopes of the outside, addendum lines $\frac{y_1}{12}$, and $\frac{z_1}{12}$, Fig. 2, may be computed.

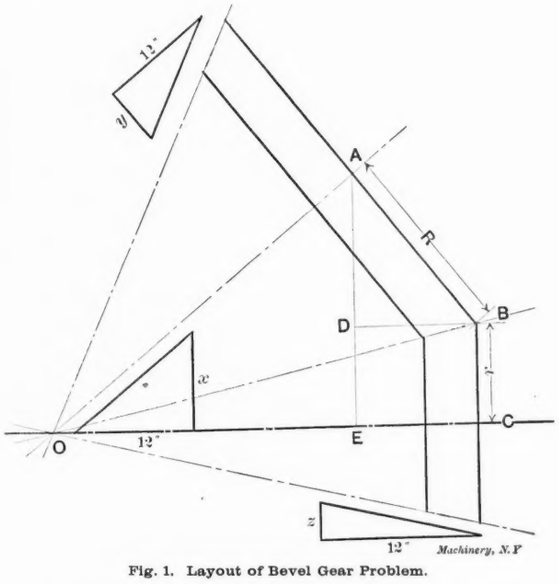


Fig. 1. Layout of Bevel Gear Problem.

Let d = the addendum laid off at C, perpendicular to the pitch line OC. Then

$$\frac{y_1}{12} = \frac{\left[R + \frac{12}{\sqrt{12^2+y^2}}d\right]x}{r\sqrt{12^2+x^2}+12R}, \text{ and}$$

$$\frac{z_1}{12} = \frac{\left[r + \frac{12}{\sqrt{12^2+z^2}}d\right]x}{R\sqrt{12^2+x^2}+12r}$$

Similarly, the slopes of the dedendum lines $\frac{y_2}{12}$ and $\frac{z_2}{12}$, are expressed by simply changing an algebraic sign, as follows:

$$\frac{y_2}{12} = \frac{\left[R - \frac{12}{\sqrt{12^2+y^2}}d_1\right]x}{r\sqrt{12^2+x^2}+12R}, \text{ and}$$

$$\frac{z_2}{12} = \frac{\left[r - \frac{12}{\sqrt{12^2+z^2}}d_1\right]x}{R\sqrt{12^2+x^2}+12r}$$

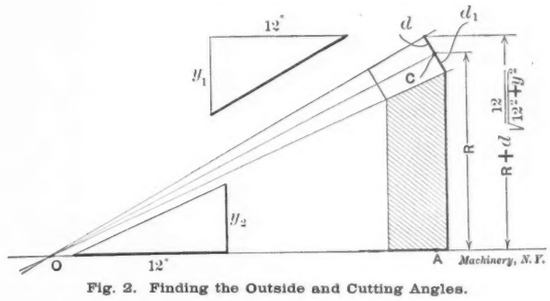


Fig. 2. Finding the Outside and Cutting Angles.

where d_1 = dedendum laid off at C.

For example, let

$x = 2$ inches
$R = 10$ inches
$r = 5$ inches

Then we have slope

$$\frac{y}{12} = \frac{10\times 2}{5\sqrt{12^2+2^2}+12\times 10} = 1.327 \text{ inch in 12 inches.}$$

$$\frac{z}{12} = \frac{5\times 2}{10\times\sqrt{12^2+2^2}+12\times 5} = 0.661 \text{ inch in 12 inches.}$$

If the gears are 2 D. P., the addendum $d = \frac{1}{2}$ inch, and the slope of the addendum and dedendum lines will be

$$\frac{y_1}{12} = \frac{\left[10 + \frac{12}{\sqrt{12^2+1\,327^2}}\times\frac{1}{2}\right]2}{5\sqrt{12^2+2^2}+12\times 10} = 1.39 \text{ inch in 12 inches}$$

$$\frac{z_1}{12} = \frac{\left[5 + \frac{12}{\sqrt{12^2+.661^2}}\times\frac{1}{2}\right]2}{10\sqrt{12^2+2^2}+12\times 5} = 0.726 \text{ inch in 12 inches.}$$

$$\frac{y_2}{12} = \frac{\left[10 - \frac{12}{\sqrt{12^2+1.327^2}}\times\frac{1}{2}\right]2}{5\sqrt{12^2+2^2}+12\times 10} = 1.26 \text{ inch in 12 inches}$$

$$\frac{z^2}{12} = \frac{\left[5 - \frac{12}{\sqrt{12^2+.661^2}}\times\frac{1}{2}\right]2}{10\sqrt{12^2+2^2}+12\times 5} = .595 \text{ inch in 12 inches.}$$

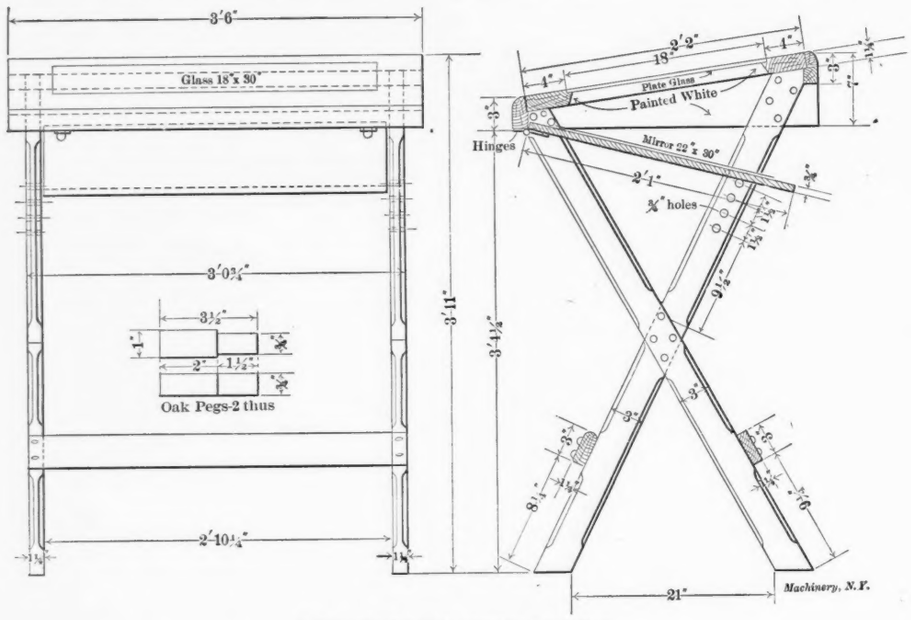
The dedendum, d_1, was assumed equal to the addendum, or ½ inch, which is near enough for this calculation.

Glenville, Ohio. A. L. WESTCOTT.

[The above-described method of figuring bevel gears has the merit of not requiring the use of a table of sines and tangents, or a protractor, so perhaps it may appeal to those of our readers who do not know how to use the one, and cannot borrow the other. It is difficult to see what other merit the process possesses, however, even in the case of small center angles, for which it is recommended, since the calculations are somewhat lengthy. The method is an ingenious one, however.—EDITOR.]

DRAWING TABLE FOR TRACING BLUEPRINTS.

The accompanying illustration shows a drawing table with a glass top that is designed to be used in making tracings of blueprints. The drawing is self explanatory and I have found



A Drawing Table for Tracing Blueprints.

a table made along these lines to be a very handy addition to a drawing office. The mirror underneath the glass top throws reflected light up through the blueprint to be traced and causes the lines to show very distinctly. A table we recently constructed was made at a total expense of $11.00, the labor, wood, and hinges amounting to $9.00, the mirror $1.05, and the plate glass 95 cents. It is not necessary to use the best quality of mirror or plate glass and this fact brings the cost down to a reasonable figure. R. F. KIEFER.

Sharon, Pa.

A WAIL FROM NEW JERSEY.

The spring days are getting in their work, and I get lots of requests for country jobs. One of the last that came in is so sad that I give it, verbatim. It is from New Jersey, so I do not blame him so much.

MY DEAR MR. PRESS:

Why don't you write and tell me that job in the country is ready? As the whistle blows at 7.00 o'clock in the morning it seems to say: "Come into the country," and as I punch the darned old clock it seems to ring: "Come into the country (no clocks there), and as I start the big lathe, the chatter of the back gear seems to say: "Come to the country," and the swish of the planer belt seems to say: "Come to the country," and the other day, after I had nearly ruined a big job because I presume my mind was on the country, the foreman came along and said: "Now, look here, my man, if you don't do better than that, we will send you out into the country."

As I went home that night, the flat-wheeled trolley car seemed to clamor: "Come to the country." Why I can even hear the rustling leaves in the tree tops and the frogs in the distant marshes, humming the same sad refrain: "Come to the country," but why continue; the only reason I am not now in the "bug-house" is that I have finally resolved to do my duty if it takes all my remaining strength. I shall probably lose two days' time in consequence of this, but never mind—I have written.

When I first came to the country, I hadn't a rag to my back, and now I am all rags, so Mr. Press, please get that job for me before it is time to plant potatoes.

I got it. A. P. PRESS.

THE IMPORTANCE OF HAVING THE FOUR FEET OF A LATHE STAND ON THE SAME PLANE.

My attention has been drawn repeatedly to the fact that comparatively few of the machinists or toolmakers who pose as first-class men realize how important it is, in order to bore a parallel hole or face a faceplate flat, that a lathe should have its four feet standing on the same plane, *i.e.*, to insure that the center line of the spindle and the ways on which the carriage travels may be parallel, the bed of the lathe must not be twisted by having one front leg resting on a higher or lower plane than the corresponding back leg.

Although I aim to have all my machines leveled up when they are installed, they do not always remain so, being on the second wood floor of a brick building. Generally when I insist on a new man doing his work accurately, before he gets used to my ways of doing things, he comes to me saying that the lathe he is using is a "bum" affair because it bores 0.0005 inch large at the back end of a hole that is, perhaps, 2 inches long, and he wants to try some other lathe to do the job. When I tell him to put a piece of tin under the back leg at the tail end of the lathe, and he finds, after doing so and taking another cut, that the hole is parallel, he says: "Well, that's quite a wrinkle. I didn't think such a thin piece would affect it so much." H. E. TWOMLEY.

Detroit, Mich.

WEAK HYDRAULIC FITTING.

The article in your May issue regarding a weak steam fitting, reminds me of an experience I had with a valve similar to this in hydraulic work several years ago.

I had rebuilt a hydraulic pump for a firm and also furnished them with a press for pressing wooden rolls into steel jackets. They did the piping themselves and the piping and the overflow were under the floor where they could not be readily reached. Upon starting the installation up, they complained that the pump would not do the work, and upon putting the gage on the same, I found that the best pressure I could get was about 400 pounds to the square inch. I jumped at the conclusion that the check valves were leaking and I spent two or three days alternately grinding the valves in and examining the same with a looking glass, and testing the pump.

The parties who had done the piping insisted that the piping was all right and the fault was entirely with the pump; therefore, on me. The way the press was operated was for the pump to run continuously and for the water to flow freely through the press cylinder when not in use, and when pressure was required the overflow was stopped with a plug cock such as I mentioned at the beginning. After trying everything I knew to make the pump work, and being unable to get a pressure over 400 pounds to the square inch, I insisted on their disconnecting the piping and allowing me to plug the outlet of the pump in order to test the same in this way. This they did, very much against their will, still insisting that the fault was with the pump. The pump was, of course, provided with a safety valve and the gage was connected with the pump and not with the piping. The gage read to 6,000 pounds to the square inch, and immediately upon starting the pump with the piping plugged, the pointer on the gage went around against the pin, showing we had something over 6,000 pounds pressure to the square inch, and the safety valve commenced to do business immediately in a way that gave us, who were near, a good shower bath before we could get out of range.

I gave the pump several tests in this way and found no trouble at all in getting 6,000 pounds pressure. This, of course, showed us that the fault was not in the pump, and upon going over the piping, fittings, etc., we found that the plug cock, which was apparently first-class in every respect, would hold up to about 400 pounds pressure; above this pressure the sides would spring in enough to allow the water to

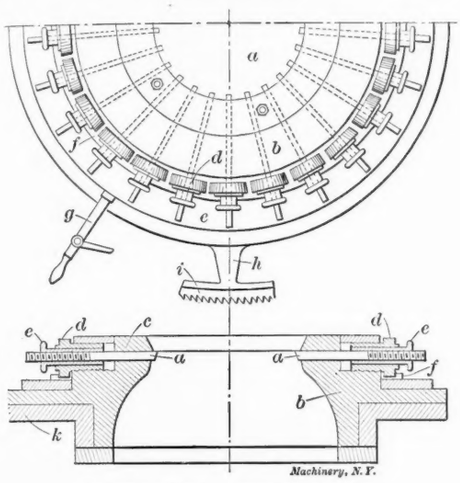
escape but would not stay permanently bent, returning to their normal condition upon the pressure being released and holding as tight as ever under ordinary pressures for which this valve was undoubtedly intended. W. P. HUNT.

Moline, Ill.

ROLL CORRUGATING DEVICE.

The device shown herewith is for the purpose of making more than one of the grooves in chilled or other rolls at once; and may be used in a planer in the same way as rigs usually employed for making one groove at a time.

With reference to the illustration the upper part shows an end view of half the device and the lower part a central cross section. The tools *a* are arranged in a circle in radial grooves



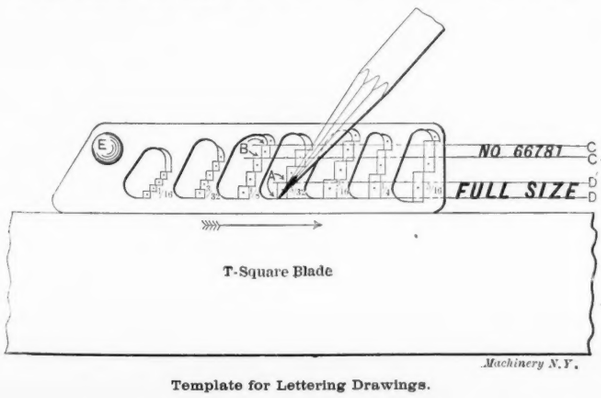
A German Rig for Corrugating Rolls.

in the casting *b*. These grooves are open above and are closed by the ring *c* which is bolted on the top of *b*. The tools are moved in or out in a radial direction by the gear pinions *d* which have long hubs threaded on the outside to fit the internal threads of the holes shown in the sectional view. All these pinions mesh with a toothed ring *f* which may be turned by the lever *g*. A movement of the lever *g* causes all the tools to travel out or in, according to the direction it is moved. The lever *h* is for the purpose of turning casting *b* which carries the tools through the necessary angle to bring them in the right position for grooving. The ratchet teeth *i* on lever *h* are for the purpose of holding the lever in a fixed position when the tools are cutting. This is firmly attached by part *k* to the tool block of the planer on which the grooving is to be accomplished. The individual cutters are adjusted by means of bushings threaded on the inside to fit the threaded portion of the tools. They serve as nuts to adjust the tools in or out.

Hanover, Germany. ROBERT GRIMSHAW.

DRAFTSMAN'S DEVICE FOR DRAWING LETTER SPACE LINES.

This handy little tool I use for drawing letter space lines. To use it place it against the T-square blade as shown in the sketch with the pencil point on the paper at the lower angle *A*. By the aid of the angle draw the line *D* by moving the pencil



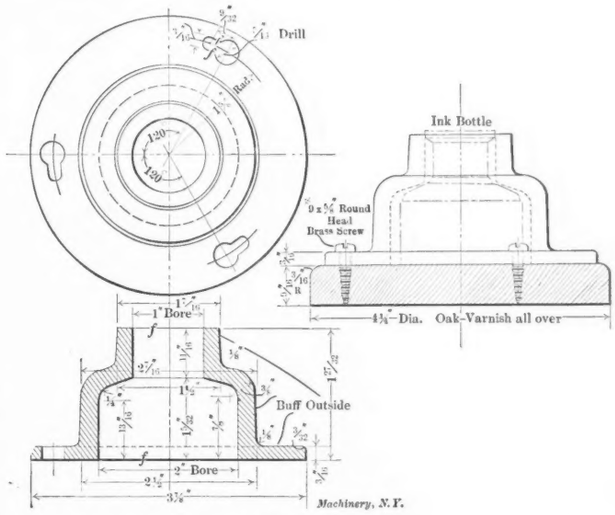
Template for Lettering Drawings.

and tool in the direction of the arrow; draw the line *D'* by the aid of the upper angle *A*, and the lines *D* and *D'* will be 5/32 inch apart. By placing the pencil point at the points *B* and following the same process the lines *C* and *C'* will be drawn ⅛ inch apart. *E* is a small knob or handle to pick it up by. The small rectangles with a dot in the center show where the notches were beveled off to let the pencil tilt. I made mine of gutta percha 1/16 inch thick, but it could be made of thin wood or of celluloid. F. W. BACH.

Ilion, N. Y.

AN INK BOTTLE HOLDER.

I noticed in the September issue a cut of an ink-bottle holder by Mr. D. E. Turnbull, which prompts me to forward you a print showing the type of ink-bottle holder used in this drafting room. This holder serves a twofold purpose, *i. e.*, to prevent spilling ink, and also as a paper weight, which explains the thickness of metal used in the construction. The wood screws are screwed down just tight enough to make a good sliding fit on the flange of brass case, and when it is desired to remove the bottle, the case is slipped around, until the



An Ink Bottle Holder.

heads of the screws come into the large diameter hole, when it can be removed from the oak bottom. Our experience with this during the last four years, has shown that it fills all requirements for which it was designed. W. O. MOODY,

Chicago, Ill. Chief Draftsman Illinois Central R. R. Co.

SPEED OF BUFFING WHEELS AND GRINDSTONES.

Wood, leather covered.....	7,000 feet per minute
Walrus hide	8,000 feet per minute
Rag wheels	7,000 feet per minute
Hair brush wheels.....	12,000 feet per minute
Ohio stones	2,500 feet per minute
Huron stones .....3,500 to	4,000 feet per minute

Howard, R. I. JAMES A. PRATT.

RUST PREVENTIVES.

Caoutchouc oil has proven to be very efficient for preventing rust, and has been adopted by the German Army. It is applied by spreading over the surface of the metal with a piece of flannel in a very thin layer, and is allowed to dry. Such a coating will afford security against all atmospheric influences and is claimed will not show any cracks even under the microscope after a year's standing. To remove the coating the article has simply to be treated again with caoutchouc oil and then washed off after standing 12 to 24 hours.

All steel articles, tools, etc., can be perfectly preserved from rust by putting a lump of freshly-burnt lime in the drawer or case in which they are kept. If the articles are to be moved about (as a gun in its case, for instance) put the lime in a muslin bag. This method of preventing rust is especially valuable for preserving the characteristics of fractured specimens of iron or steel. In a moderately dry place the lime will

not need renewing for many years as it is capable of absorbing a large quantity of moisture. If the tools are in daily use they should be placed in a box nearly filled with thoroughly pulverized slaked lime; before using them rub well with a woolen cloth. A. L. MONRAD.

New Haven, Conn.

INDEX FOR POCKETBOOKS.

Many have undoubtedly noticed the different forms in which the same information appears in the various engineers' pocketbooks, some of it complete and some of it less so. In the case of the tables most commonly referred to, the writer has found it convenient to cross index his pocket book as it were, and if working in Kent, for instance, and desiring a table of prime factors, one would see by reference to this index in the fly leaf that such a table could be found in Suplee or the pocketbook of the International Correspondence Schools. This index is shown herewith and may be of use to other readers of MACHINERY. ROBERT S. BROWN.

New Britain, Conn.

Thus I am able to let the die remain in the bath, allowing them both to cool together and thereby obtaining results similar to those described by Mr. Shailor.

New York. H. J. BACHMANN.

ENVELOPE SYSTEM FOR FILING DATA.

The arranging of data for ready reference has been to me quite a problem for some years past. First, I pasted my clippings in a book which was too small. Next, I got a well-made cloth-bound catalogue and removed some of the pages and took the clippings from the old book and pasted them into the new one. But I have decided now that the best method of keeping them is to have envelopes in which to put them, and have them under proper classification; for instance, all information concerning spur gearing is placed in one envelope. Bever, spiral and worm gearing each have a separate envelope. Belts and pulleys in one and ball and roller bearings in another, and so on. Small articles, such as taper pins, cotter pins, ratchets, Morse and B. & S. tapers are put into the same envelope.

	Kent.	Suplee.	International Correspondence School.	Practical Engineer.	Mechanical World.	Carnegie.	Pencoyd.	Jones & Laughlin.
Logarithms	6 place	5 place.	5 place.	5 place.	5 place.	5 place.	5 place.	1 to 100.
Hyperbolic Logarithms.	1 to 10 by 100ths. 10 to 50, 4 place.	1 to 10 by 100ths. 10 to 134, 7 place.		1.1 to 10 by 10ths. 10 to 20, 4 place.	1.1 to 10 by 10ths, 10 to 20, 4 place.			
Circumferences of Circles. Kent also has a table to 33 feet by inches in feet and inches. J. and L. ditto.	1 to 1000, 6 figures. 1 by 32ds, 5 figures. 6 by 16ths, 5 figures. 100 by 8ths, 6 figures.	1 to 1000, 6 figures.	1 by 16ths, 5 figures. 100 by 8ths, 6 figures.	100 by 10ths, 4 figures. 1 by 32ds, 4 place. 5 by 16ths, 5 figures. 100 by 8ths, 5 figures.	100 by 10ths, 4 figures. 1 by 32ds, 4 place. 6 by 16ths, 5 figures. 100 by 8ths, 5 figures.	1 to 1000, 6 figures. 12 by 16ths. 5 figures.	1 to 1000, 6 figures.	1 to 100, 4 figures. 3 by 16ths, 4 figures. 10 by 4ths, 4 figures. 10 by 20ths, 4 figures.
Areas of Circles. J. and L. have a table to 33 feet by inches in feet and inches.	1 to 1000, 2 place. 1 by 32ds, 5 place. 6 by 16ths, 3 place. 100 by 8ths, 1 place.	1 to 1000, 6 figures	1 by 16ths, 6 place. 100 by 8ths, 2 place.	100 by 10ths, 6 figures. 1 by 32ds, 4 place. 5 by 16ths, 5 figures. 100 by 8ths, 5 figures. .1 by .001, 7 place. 1 by .01, 4 place.	100 by 10ths, 6 figures. 1 by 32ds, 4 place. 5 by 16ths, 5 figures. 100 by 8ths, 5 figures. 1 by 001, 7 place 1 by .01, 4 place	1 to 1000. 6 figures. 12 by 16ths, 5 figures.	1 to 1000, 6 figures. 8 by 16ths, 5 figures. 100 by 8ths, 5 figures,	10 to 100, 1 place. 3 by 16ths, 4 figures. 10 by 4ths, 4 figures. 10 by 20ths, 4 figures.
Squares and Cubes Square Roots and Cube Roots *Squares only.	1 to 1600, 4 place. 1 by 20ths. 4 place.	1 to 1600, 7 place.		1 to 50 by 10ths, 2 and 3 place. 50 to 100. Roots all 4 place.	1 to 50 by 10ths, 2 and 3 place. 50 to 100. Roots all 4 place.	1 to 1000, 4 place. 12 by 16ths, 5 figures *	1 to 1000, 4 place.	up to 1250.
Higher Powers.	1st 9 powers of 1st 9 numbers.			4th powers from 1 to 10 by 8ths.	4th powers from 1 to 10 by 8ths.			
Prime factors.		1 to 9600.	1 to 1000					
Nat. Sines and Tang. *Sines only.	15 min., 5 figures.	1 min. 5 figures.	10 min., 4 place.	10 min.,* 4 place.	10 min.,* 4 place.	10 min., 5 place.	10 min., 5 place.	10 min., 4 place.
Log. Sines and Tang.	1 deg., 5 place.	1 min., 5 figures.						1 deg., 4 place.

An Index of the Tables in the Standard Pocketbooks.

HARDENING WITHOUT CRACKING.

Mr. Shailor's "Hardening Without Cracking" in the February issue is, in my humble opinion, the best and simplest method of die hardening that has been published in a long time. The "young fellows" (among them yours truly) must indeed be "thick" if they cannot catch the point he has so ably brought out. While the means employed by myself have been slightly different the end attained has been the same, *viz.*: Not allowing the die to become cold in the bath. I simply bring my pail of water to a temperature of about 80 degrees and plunge the die, thereby raising the temperature of the water to about 130-150 degrees or just too hot to bear the hand.

In this way the subject wanted can be located in a short time, and all I have upon any one subject (except that in text books) is found together. Heretofore, when placed in book form, different articles upon the one subject would be scattered throughout the book and much time lost in hunting for them. Another disadvantage with the book was that ofttimes there would appear information on each side of the clipping and in order to preserve each it would be necessary to fold over an edge and paste it into the book, but this crease would soon break open and cause more trouble.

Draftsmen to whom I have shown my method consider it to be well adapted. The envelopes are 5 x 8 inches, made of

strong manila paper. I use twenty-five envelopes, make two bundles of them and keep them together with elastic bands.

Bridgeport, Conn. C. E. JOSSELYN.

BACKING-OFF SPRING AND BUTTON DIES.

Some time ago I had occasion to make a number of special button and spring dies for screw machines of the form shown in Figs. 2 and 3; the puzzle was how to back the dies off or give them lead for the first threads on the cutting end. After trying several devices, I finally hit on the tool shown in Fig. 1,

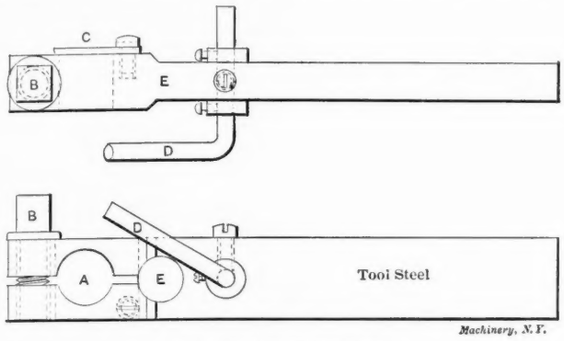


Fig. 1. Holder for the Dies.

which is made of tool steel and spring tempered at *E*. The dies of the spring style were inserted at *A* and clamped by the screw *B*, making sure that they were back against the stop *C*. The lever *D* was used as a stop being engaged with the flutes on the dies. I used this tool in the toolpost of the lathe, setting it a slight angle, if necessary, according to the lead or taper desired. The reamer countersink, Fig. 5, was held in

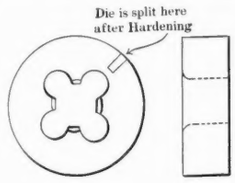


Fig. 2. Button Die.

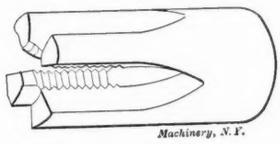


Fig. 3. Spring Die.

the chuck. A stop was clamped on the lathe bed and another on the cross feed of the lathe carriage, so that the travel in both directions was fixed.

For backing off button dies I used the bushing shown in Fig. 4, and for spring dies too large to go into the holder plugs were used which fitted the clearance hole in the dies, the plugs being clamped in the holder the same as the smaller spring dies. Although this tool may seem a rather peculiar

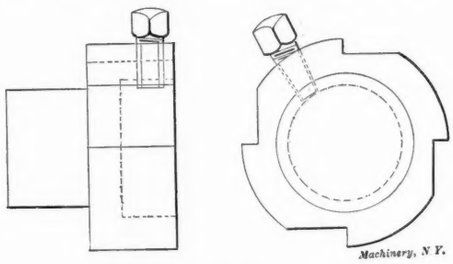


Fig. 4. Holder for Spring Dies.

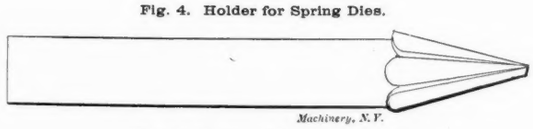


Fig. 5. Tool used for Backing-off.

device for backing off dies, it is away ahead of the file, and is just as good as special machines designed for the purpose. It will be found to effect a great saving, especially when one has no machine for the purpose; it is very easy to set, and in changing the dies one is simply taken out and another put in place without moving the tool or disturbing any of the adjustments. I generally smooth the dies up with a small half-round file after backing off in order to insure a keen cutting edge. For long threads I give the dies about four or five threads lead when they are not expected to cut up to a shoulder.

JOHN S. SCOTT.

Lowell, Mass.

THICKNESS OF CUTTERS FOR TAPS AND CHUCKING REAMERS.

In selecting half-round milling cutters for taps, and chucking reamers, the following formula will give satisfaction in determining the proper thickness to be used on the fluting:

$$T = \frac{8D}{3A}$$

T = thickness of cutter.
D = diameter of tap or reamer.
A = number of flutes.

To illustrate, suppose we wish to cut a ½-inch tap, having four flutes. Then we have $\frac{8 \times \frac{1}{2}}{3 \times 4} = 1/3 = 0.333$ inch for the thickness of cutter. The thickness of a half-round cutter for cutting a twist drill, will be about 7/9 the diameter of the drill.

J. A. P.

* * *

One of the perplexing problems of vehicle propulsion has been to devise some practical form of motor-driven sleigh for traveling on snow and ice. The usual type of experimental machine in this direction has been some form of the ordinary sleigh with a spiked traction wheel suspended so as to dig into the snow or ice and furnish the propelling force. It is a somewhat curious fact that the screw principle of propulsion should not have been developed for this purpose long ago. In the sleigh we have an example of the most primitive vehicle, being simply a pair of curved runners attached to and supporting a body. It is, however, one that offers very little resistance to motion because of the very slight coefficient of friction of snow and ice; in fact, the resistance of the sleigh on a good track is phenomenally low. One pair of horses can draw enormous loads as has been proven many times in lumber woods, loads of logs weighing 30 or 40 tons having been hauled by a team, where the conditions were favorable. For this very reason the screw system of propulsion would be working under the most favorable conditions, for the principal retarding factor of the screw is its friction, being as it is, an example of "wedge" action. If the runners were made in the form of screws or helices of considerable pitch and these were driven by power it would seem that such a "sleigh" should offer fairly small resistance to motion and should be quite efficient in operation. The revolving screws would tend to climb on top of the snow, and a momentary stoppage would not break the traction hold as is the invariable tendency with the spiked wheel tractor. It is of course quite easy now to make the suggestion, inasmuch as the principle has already been tried out and found to be fairly successful, as was noted in a recent issue of MACHINERY. But, the point to be made is that a thorough analysis of the subject should have pointed out such a system of propulsion long ago. Perhaps the habit of thorough analysis of any subject is one that very few people possess. The born inventor certainly does not have it. He has a way of jumping at conclusions—generally he jumps wrong, but sometimes he hits it all right.

* * *

The Pennsylvania Railroad Motive Power Engineering Association was organized March 6, 1906, by members of the mechanical engineer's office at Altoona, Pa., for the purpose of presenting papers and holding discussions on engineering subjects for mutual development and enlightenment. It is the intention to choose such subjects as are of general engineering interest, and also those which have a direct bearing on work in which the members are engaged. As indicated by the name, membership is limited to employees of the Pennsylvania Railroad and is still further restricted to all persons engaged in engineering work. The officers are C. E. Barba, president; R. N. Kennington, secretary; G. Peterson, secretary, and U. S. Drayer, treasurer. At the first meeting Mr. A. S. Vogt presented a paper "Locomotives and Cars."

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CHALK AS A LUBRICANT FOR LATHE CENTERS.

Chalk will prevent the centers of a piece being turned in the lathe, from cutting and squeaking. C. P. L.

DETERMINATION OF PROPER AMOUNT OF SALT IN HARDENING BATH.

It is common practice to use salt in a hardening bath; put enough in so the mixture will float a potato and your bath is about the right density.

Howard, R. I. JAMES A. PRATT.

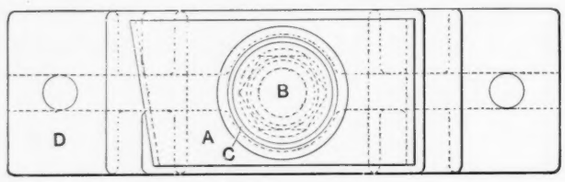
SALT BATH FOR HEATING.

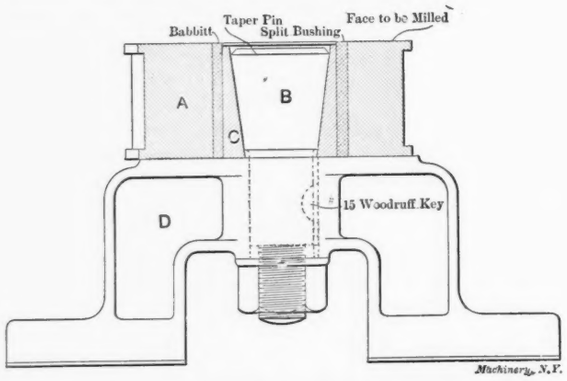
A salt bath is a convenient and satisfactory substitute for lead, when heating articles for hardening or annealing. Fill a receptacle with fine salt, place the article or articles in it and bring to desired heat; the subsequent treatment is same as for any other method of heating. JAMES A. PRATT.

Howard, R. I.

ROD BRASS FACING FIXTURE.

The cut shows a fixture for facing the sides of a certain type of connecting-rod box, either on the milling machine or engine lathe. The fixture, *D*, is bolted to the table or face-plate, as





the case may be; the boxes are first babbitted as shown. A split taper bushing, *C*, is made to suit the hole in the box, and bored tapering to suit the pin, *B*, which is drawn in by the nut on the under side. I. N. QUIRE.

TO LAY OUT ANY ANGLE WITHOUT A PROTRACTOR.

To lay out any angle without a protractor or any other tool but a scale and dividers, strike an arc with a radius of 3.58 inches; then every 1-16 inch on the arc is almost exactly one degree. For most ordinary purposes a radius of 3 9-16 inches may be used, the error being only about 1 degree in 360.

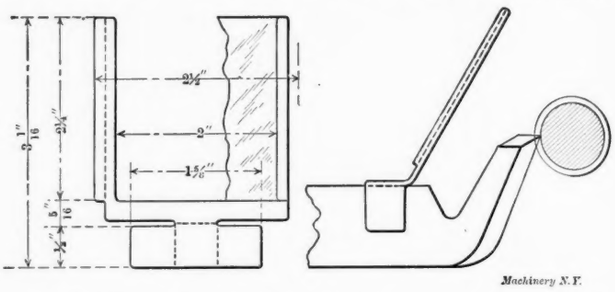
Stamford, Conn. EDGAR WERNER.

TO LOOSEN PASTED PAPER.

Sometimes it is desirable to loosen clippings that have been pasted in scrap-books, etc. To remove them by soaking in water is slow and is likely to injure the clipping or book unless extreme caution is employed. This trouble may be largely avoided by covering the face of the clipping with flour paste instead of water; the fresh paste soaks into the paper quickly and loosens the dried paste underneath. When the clipping is loosened the fresh and dried paste is readily washed off, of course. The same trick will be found to work well with old wall paper. The superior action of paste to water is due to its wetting the paper all over and having no tendency to run off. M. E. CANEK.

CHIP GUARD FOR LATHE TOOLS.

To protect the face from flying chips when turning in a lathe a chip guard may be applied to the tool as shown in the cut. It is made of brass, and bent as shown in the dotted



lines, a piece of mica, celluloid or wire gauze being pinched between the edges. This makes a more or less transparent guard and is superior to the common tin substitute for this reason. C. E. J.

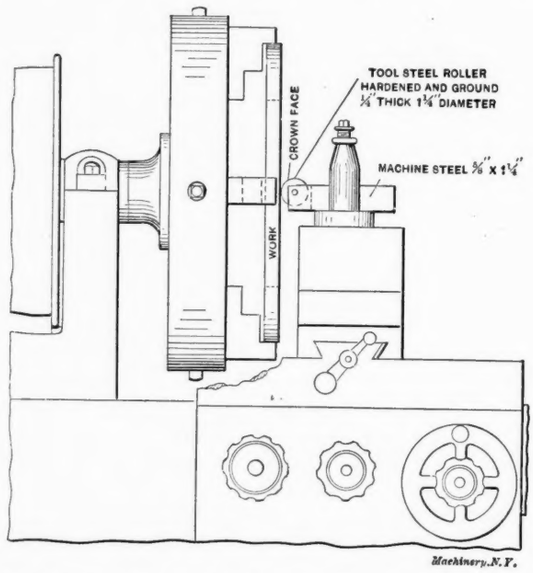
A SIMPLE WELDING FLUX.

The foreman of a large blacksmith shop gave me the following, which may be of use to your readers. We were speaking of the slag that is formed in the furnace, daily, when he said that he used it altogether as a flux for welding cast steel frames and other broken parts that occur in the repair of locomotives and other railroad work. All that is required is to pulverize it with a hammer when it is ready for use. It is applied as any other flux would be. WM. NEWTON.

Oneonta, N. Y.

TO TRUE UP WORK IN THE LATHE.

The cut shows a scheme for truing up any flat piece of work in the lathe chuck with accuracy and despatch. The roller tool is brought to bear on the work (which is lightly



caught by the jaws) with a light pressure, moving towards it as the work rotates, and in a few revolutions it will be found to run true. MARTIN WATROUS.

Ansonia, Conn.

* * *

The art of advertising has many followers and the tricks and devices employed are legion. A picture is given in a farm journal which is supposed to show a noted plow manufacturer plowing in a field on his farm, but to all intents and purposes the gentleman is posing for his picture, in the husky attitude of holding to the plow handles (his make) while the horses stand at rest!

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

183. TO FASTEN PAPER LABELS TO IRON OR STEEL.

Rub the surface over with an onion cut in half. Then apply the label with glue or paste. L. E. MUNCY.
Syracuse, N. Y.

184. LACQUERING EFFECT ON POLISHED STEEL.

Mutton suet burnt on a polished surface produces a brilliant black which is very lasting. H. T. MILLAR.
Manchester, Eng.

185. TO PREVENT EXPOSED IRON RUSTING.

To prevent iron, which is exposed to moisture, from rusting, paint over with a coat of Portland liquid cement. This is very satisfactory for posts which are set in the ground.
Howard, R. I. JAMES A. PRATT.

186. BRONZING FLUID FOR STEEL.

To obtain a light bronzing fluid use nitric acid, 6 parts; nitric ether, 5 parts; alcohol, 5 parts; muriate of iron, 5 parts. Mix thoroughly and then add 10 parts sulphate of copper dissolved in 50 parts of water. O. G.

187. TO KEEP STEEL TOOLS IN THEIR HANDLES.

To keep steel tools in their handles, fill the handle with powdered rosin and a little rotten stone. Heat the tang of the tool hot, and then push it down hard into the handle; when it is cold it will be firmly set. M. E. HOWE.
Worcester, Mass.

188. TO REMOVE GREASE STAINS FROM PAPERS, DRAWINGS, ETC.

Place sheets of blotting paper over and under the stained page, to protect the others. Lay powdered magnesia on the stain and under it; then press over the blotting paper with a hot iron. When the powder is shaken off, the stain is gone.
New Britain, Conn. F. L. ENGEL.

189. TO PRESERVE REFERENCE TABLES.

Reference tables are very convenient to use but soon get dirty and torn. To prevent this pour some lacquer in a shallow tray and dip the paper into it and hang it up to drain and dry. This not only makes the paper dirt-proof but toughens it as well. MILTON BURGESS.
Cleveland, O.

190. A CEMENT FOR MENDING RUBBER GOODS.

Dissolve raw gum rubber or caoutchouc in bisulphide of carbon for a number of days in a tightly stopped bottle until it has the consistency of a thick paste. Make the surfaces to be cemented clean and dry before applying, and press joint tightly together. L. E. MUNCY.
Syracuse, N. Y.

191. TO CEMENT EMERY CLOTH TO POLISHING DISK.

Apply quickly to the disk with a broad flat brush a coat of moderately thick shellac varnish. Lay on the emery cloth and place under a press at once. The shellac varnish must be clean and without lumps as these may not be pressed down to an even surface and so cause scratches in the work.
Neponset, Mass. OSCAR E. PERRIGO.

192. TO REMOVE STEEL CHIPS FROM JIGS AND THE LIKE

It is often very desirable to remove chips of steel from jigs and the like each time a new piece is inserted. An easy way to do this is to put a pound of caustic soda in a gallon of water and dip the jig in every time it is desired to remove the chips. F. PAVLIK, JR.
Winnetka, Ill.

193. SOLUTION FOR WRITING ON BLUEPRINTS.

In reply to the inquiry of D. C. T. in the December issue, for a solution for marking on blue-prints, would say the best I have tried is a very thick lime water. Have a good deal more lime than will dissolve and shake up the bottle just before using, and it will not spread. Possibly this solution could be colored with red ink, but as I prefer the white I have never tried it. G. V.

194. LUBRICANT FOR LATHE CENTERS.

I have tried many different kinds of lubricants for lathe centers and as yet I have found nothing equal to white lead mixed with sperm oil, with enough graphite added to give it a dark lead color. It can be mixed and kept in small tin boxes; add oil when necessary to keep it from getting too thick. S. C. S.

195. SOLDERING ALLOYS.

I have used the following soldering alloys and can recommend them:

For copper with copper: Copper, 55; zinc, 40; tin, 5.
For copper with iron: Copper, 80; zinc, 16; tin, 4.
For brass: Copper, 45; zinc, 50; tin, 5.
For lead: Lead, 67; tin, 33.
Los Angeles, Cal. J. M. MENEGUS.

196. TO TOUGHEN AND SURFACE HARDEN CAST IRON.

To toughen and surface harden small cast iron machine parts, which are subjected to wear, such as small gears, cams, etc., heat to a dull red and quench in a saturated solution of cyanide of potash and water which should be kept as near boiling point as possible. This can be accomplished best by putting the solution in an iron pot near the fire in which the parts are being heated. J. H. V.

197. GLUES WHICH RESIST MOISTURE.

A glue cement that resists moisture is made by mixing with the least possible quantity of water 1 part glue, 1 part rosin and ¼ part red ochre.

Another glue which resists moisture is made of one pint glue melted in two quarts skimmed milk. Add powdered chalk to make it stronger.

A marine glue is made of one part of india rubber, 12 parts naphtha. Heat gently, mix and add 20 parts of powdered shellac. Pour out on a slab to cool. When used it has to be heated to about 250 degrees F. A. L. MONRAD.
New Haven, Conn.

198. TO CLEAN JEWELRY, SILVERWARE AND METALS.

The following receipt is one that not all jewelers know. It can also be used to clean the hands on special occasions; it will not crack the hands if vaseline is rubbed in well immediately after rinsing them off in water:

Make a saturated solution of cyanide of potassium by taking a quantity of water, and dissolving the cyanide in it, until no more cyanide will dissolve. Dip the article in this solution until the dirt is eaten off (this takes but a short time) then rinse off in hot water, and dry in boxwood sawdust. The article will then look better than when new.
St. Paul, Minn. PARKE B. SHEE.

199. TO PRODUCE BROWN FINISH ON STEEL.

To produce the rich brown finish that is commonly used on large guns use sulphate of copper, 1 ounce; sweet spirits nitre, 1 ounce; distilled water, 1 pint.

Four coats are applied, allow several hours to elapse between the successive coats, brushing after each if necessary. After the last coat, rub down hard and allow to dry 24 hours. This gives a reddish-brown color without gloss. By adding arsenic to the mixture before last coat a deeper hue is obtained. The polish is obtained by means of a mixture of boiled oil, beeswax, and turpentine, comparatively thick. Rub in well with cotton cloth and finally with the palm of the hand. R. P. PERRY.

* * *

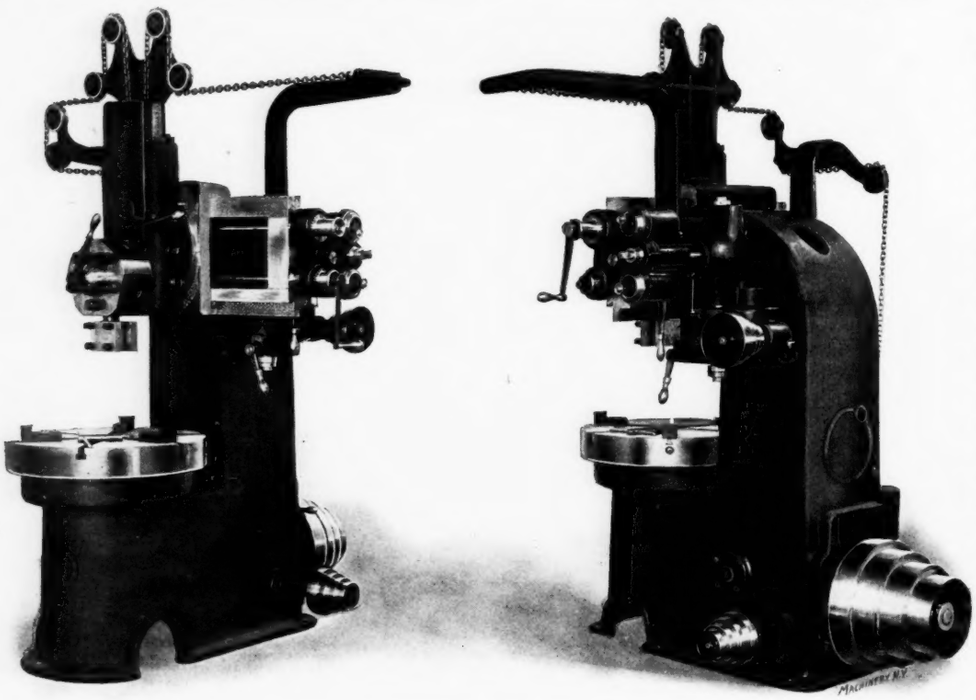
A convenient rule for approximating the time required for turning locomotive tires with the best modern driving-wheel lathes is to allow one minute per inch of diameter. For example, a 60-inch tire would require about 60 minutes for the actual turning according to this rule, the time of setting and removal from the lathe being additional.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

GISHOLT VERTICAL BORING MACHINE.

In the accompanying halftone is shown a vertical boring mill developed by the Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. The tool is designed to be a thoroughly accurate and serviceable one, but at the same time to be sold at a moderate cost. With this end in view changes in feed and speed are made largely by cone-pulleys and shifting belts. The headstock is driven by means of a four-step cone. A two-speed countershaft and back gearing operated by a positive



Gisholt Thirty-inch Vertical Boring Mill.

clutch give sixteen speeds in all. All gears are encased, and all those subject to heavy duty are of steel. The machine may be motor-driven if desired. There are eight feeds ranging from 1-64 to ¼ of an inch per revolution. Any feed, vertical, horizontal or angular, may be operated by hand or power. Micrometer index dials reading to 0.001 inch are provided for all feeds, together with an automatic tripping device which will always stop the feed positively at the end of its traverse. The table is furnished in two styles, either as a universal and combination chuck fitted with three movable jaws and nine radial T-slots, or a plain faceplate with twelve radial slots. The turret is five-faced and has 2¼-inch holes. The height under the rail is 17½ inches. The floor space is 63 x 63 inches. Extreme swing, 34 inches, diameter of table, 28 inches; the total gearing ratio is 20½ to 1. The machine weighs about 5,000 pounds.

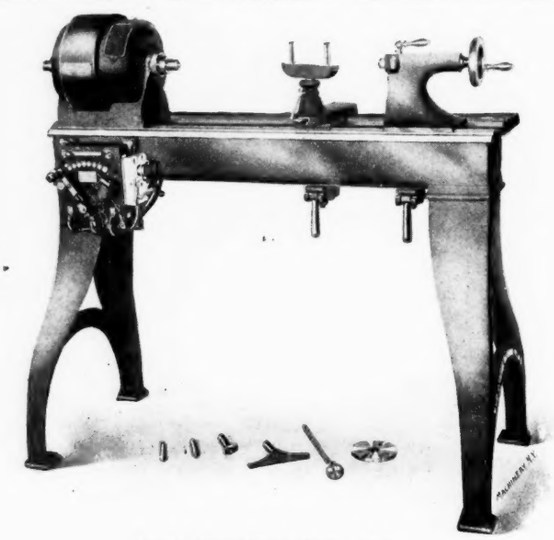
GARVIN MOTOR-DRIVEN SPEED LATHE.

The accompanying illustration shows a motor-driven spinning or hand lathe recently brought out by the Garvin Machine Co., Spring and Varick Sts., New York City. The headstock is fitted with a 1 horsepower motor, direct connected with the hollow steel taper spindle, of standard size, running in gun-metal boxes. The motor is equipped with a Cutler-Hammer controller for a 110-volt current, giving a range of speeds between 800 to 2,000 revolutions per minute.

The machine itself is the regular standard 12-inch swing lathe, made by this company. The bed is wide and deep, and is closed top and bottom, except for a narrow slot for the binder bolts, and is ribbed internally to secure rigidity. The tool-rest and tailstock are bound by powerful cam-binders. A wooden shelf, supported by iron brackets, extends the whole length of the bed at the back, and is convenient for holding work and tools. This lathe is made in 10-inch, 12-inch and 15-inch swing, and can be furnished with wheel, lever, or combination tailstocks, as may be desired. It is a high-grade tool, and adapted to toolmakers' use.

REVERSIBLE TAP HOLDER AND SAFETY CLUTCH.

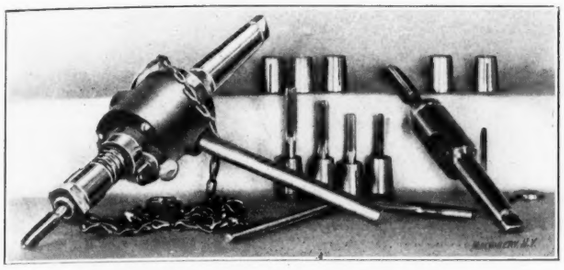
The Mutual Mfg. Co., Bridgeport, Conn., have placed on the market the tapping attachment shown in the cut. This attachment is of the type which does not require the spindle or the drill press, or other macine, to be reversed. When the tap has reached the required depth it is backed out by the mechanism enclosed in the body of the attachment. The forward motion is transmitted directly from the spindle to the tap by a friction drive. The thumbscrew at the lower end of the case is used to regulate the distance to which the pin shown projects from the casing. This pin engages a similar one in the revolving collar on the tapping spindle. When the tap has entered the hole to such a depth that these two pins are out of engagement with each other the tapping spindle is reversed by a friction clutch, and the tap backs out. The attachment may be prevented from rotating either by the handle shown or by attaching the chain to some stationary part of the machine, whichever way is most convenient. The chuck in which



Garvin Motor-driven Speed Lathe.

the tap is held is shown separately at the right of the cut. A bushing is used which fits the shank of the tap, this bushing having a tapered outside diameter which is fitted to the interior of a nut screwed into the chuck. This nut seats against a solid shoulder. The abutment for the rear

of the bushing, however, is formed by another adjustable nut at the rear, which may be tightened or loosened through the openings at the side. By turning this nut the bushing may be firmly gripped in place or may be held with so light a pressure that it can be revolved with the fingers. This provides an easily adjustable friction drive which may be tightened to such an extent as to carry the tool being used, without, at the same time, having strength enough to break it. This chuck is sold separately as well, for use with either straight or taper shank drills up to ½ inch in diameter.



A Reversible Tap Holder and Tools used with it.

CUTTER GRINDER ATTACHMENT FOR DRILL GRINDER.

The Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., as may be seen from Fig. 1, are applying a simple cutter and reamer grinder to their well-known "Yankee" drill grinder, thus making a combined machine which pretty well fills the requirements of a small tool room. The construction of the drill grinder is well-known, it being such that each drill, on account of the peculiar relation between the axis on which it oscillates and the angular V-shaped trough in which it is placed, determines its own position by its diameter, thus doing away with the necessity for any adjustment for the size of the drill.

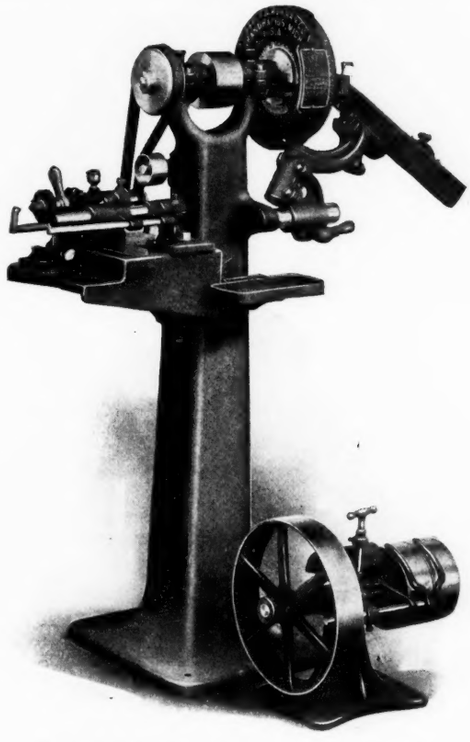


Fig. 1. Drill Grinder with Cutter Grinder Attached

The cutter grinder spindle carries a 1½-inch pulley for a 1-inch belt, and is driven from a 4¾-inch pulley on the drill grinder spindle. The spindle of the cutter grinder is hardened and ground and runs in an eccentric sleeve whose position may be altered by the handle shown, to adjust the emery wheel toward the cutter to be ground. The wheel used is 2½ inches in diameter with a ½-inch face. Fig. 2 shows the grinding of an angular mill in this device. The cutter is supported on a swiveled head on the carriage, this being adjustable to any angle. This same head is utilized for grinding the sides of face mills. Large straight and spiral milling cutters and shell reamers are supported on the main bar on which the swivel head travels. Cutters in which the diameter of the hole is so small that they cannot be ground in this way can be supported on an arbor between centers which are provided for such work as this and for grinding taper reamers, etc. The base of the device is provided with T-slots so placed that the chief parts can be adjusted in such relation to each other as to bring the various cutters and reamers in proper position in relation to the emery wheel.

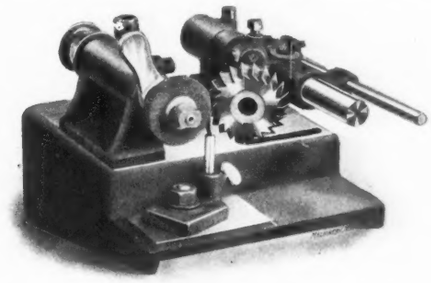


Fig. 2. Cutter Grinder Set for Sharpening Angle Cutter.

THE HEALD ROTARY SURFACE GRINDER.

The Heald Machine Co., Worcester, Mass., have been making improvements in their rotary surface grinder. To meet the requirements for heavier and more accurate work, the machine has been supplied with water guards around the grinding wheel, and a rectangular box about the chuck which takes care of the water used in grinding. A water tank will be noticed at the rear of the pedestal. This is provided with a centrifugal pump on a vertical axis to furnish water to the wheel. The machine as shown, arranged for wet grinding, is well adapted to finishing hardened steel parts, thrust collars, slitting saws, and case-hardened pieces, since the use of water guards against drawing the temper of the work, and, in the case of thin pieces, overcomes the tendency to spring or warp out of shape from unequal heating.

The action of this machine is readily apparent. The spindle with its magnetic chuck may be revolved at a suitable rate of speed for the work in hand. The rotating grinding wheel is reciprocated back and forth radially over the work from center to circumference and back again, the work meanwhile being fed upward by the circular nut which acts on a thread cut in the lower spindle sleeve. By this means the whole spindle and the attached chuck and work is raised vertically to give the proper depth of cut to the wheel. The feeding mechanism has been improved over former designs in the

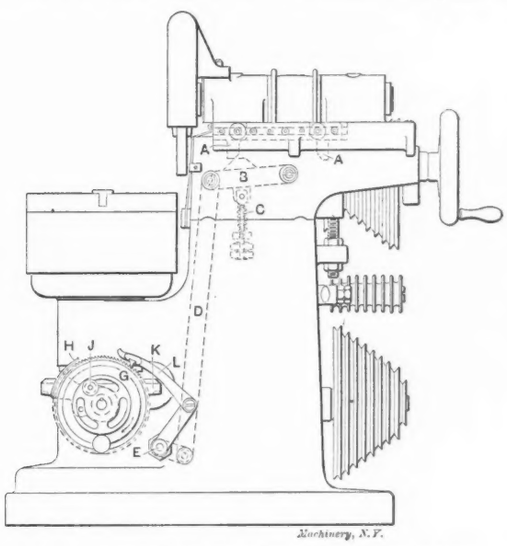


Fig. 1. Automatic Feed Attachment on Heald Ring Grinder.

machine shown in the cut, by adding a hand wheel and bevel gears to allow a finer and more convenient adjustment. An automatic vertical feed will be provided for use in connection with this machine, if desired. Where there is much stock to be removed this attachment renders the machine self operative, allowing it to grind continuously until the desired thickness is obtained, at which point the feed is thrown out and the machine is ready for a new piece of work.

The operation of this automatic vertical feed will be readily understood from Fig. 1. The reciprocating head which carries the emery wheel is provided with a slot in which are fastened dogs *A A*. These dogs actuate lever *B* by striking the cam surface formed on its upper side. After the machine is set for a given stroke, dogs *A A* may be so adjusted as to depress this lever at each end of the movement of the head to any depth desired, depending on their position. A spring *C*, whose tension is adjustable, returns the lever to its previous position as soon as the dogs start on their return travel. The intermittent movement of lever *B* is transferred to rock shaft *E* through link *D*. To an arm pivoted on this rock shaft is attached pawl *L*, which has a hardened tooth engaging with teeth formed in the periphery of ratchet wheel *G*. It is evident that this mechanism provides for a movement of wheel *G* in the direction of the arrow at the end of each stroke of the head, this movement being adjustable at the desire of the

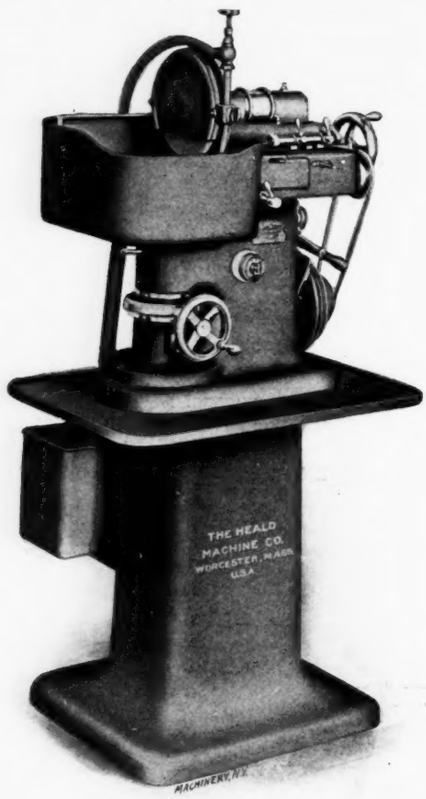


Fig. 2. Heald Ring Grinder arranged for Wet Grinding.

operator. Wheel *G*, which takes the place of the hand wheel shown in Fig. 2, is connected by gears with nut *K*, which raises or lowers the spindle and feeds the work toward or away from the emery wheel. To stop the feed when the work has been ground to the proper thickness a guard *H* is provided, mounted on a swinging sector which may be clamped at any desired position in relation to the periphery of the ratchet wheel *G*, by means of a clamp screw *J*. When guard *H*, traveling with wheel *G*, has been brought by the pawl *L* to such position that the teeth under the pawl are covered, feeding is of course stopped. The spindle may then be lowered again while a new piece of work is inserted.

DRAWING-BOARD STAND.

A neat folding and adjustable metal trestle for holding drawing boards has been brought out by Williams, Brown & Earl, Philadelphia. This trestle, in connection with a drawing board, makes a convenient draftsman's table, adjustable to any desired height and so braced that it is rigid and firm. It can be used for holding drawing boards of any size and can

Fig. 1. Adjustable Folding Drawing Stand.

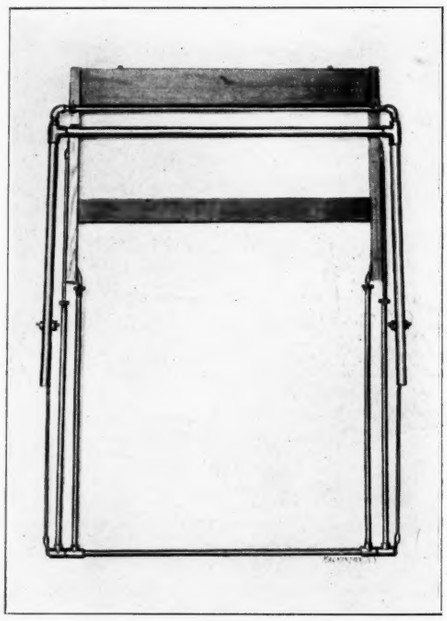


Fig. 2. Drawing Stand Folded.

be folded into small compass, making it convenient for use where a drawing table is to be transported. It is also well adapted for home use because of the small space occupied when folded.

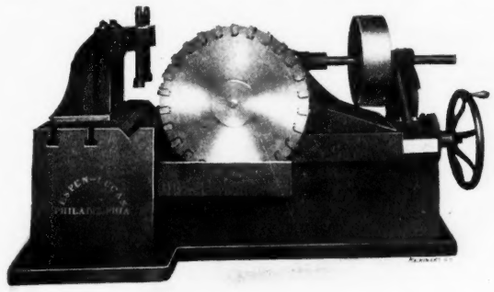
STEEL FOUNDRY COLD SAWING MACHINE.

The Newton Machine Tool Works, Philadelphia, Pa., are the builders of the saw shown in the engraving. It is known as their No. 0 steel foundry cold saw cutting-off machine and, as shown, is arranged for belt drive. The spindle is mounted on a ram which has an automatic feed of 18 inches in length variable through friction disks. An in-and-out hand adjustment and power quick return are provided. The saw is 32 inches in diameter and is of the Taylor-Newbold inserted tooth design, and is driven through spur gearing by a worm and worm wheel of steep pitch. An adjustable work table is provided which allows the work to be clamped in place and afterward adjusted to bring the saw to the proper point for action. It has capacity for cutting gates and risers up to 9 inches in diameter. One of the users of the machine reports that it has been cutting off 8-inch by 8-inch sink heads in eight minutes.

THE ESPEN-LUCAS COLD SAW CUTTING-OFF MACHINE.

The machine illustrated below is one which has been tried out in actual practice and has given very satisfactory results. It was especially designed to drive a saw made with inserted teeth of high-speed steel and is so constructed that it has ample power and stability to drive a saw of this description up to its limit of capacity. The intention has been, in fact, to give the machine sufficient strength to allow it to meet such demands as improvements in saws and tool steel may require of it in the future.

The capacity of the machine is such that it easily handles 9-inch round steel. The saw is driven by a hammered crucible steel worm and phosphor bronze worm wheel, through compound gearing of hammered crucible steel cut from the solid. A variable automatic feed is provided, controlled by an automatic stop which may be set for any depth of cut. The work



Espen-Lucas Cold Saw Cutting-off Machine.

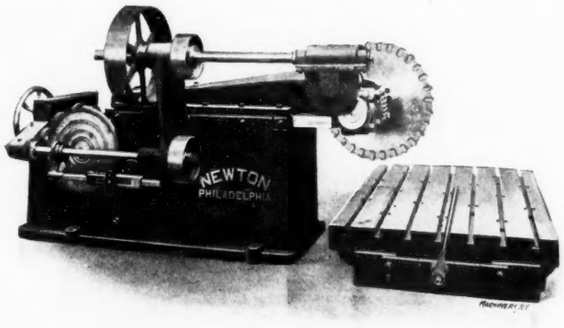
may be held on any part of the platen at any angle by means of swiveled clamps provided with the machine. For special work, these clamps may be removed and any suitable devices used for holding the work, thus providing for every possible contingency. The machine is a product of the Espen-Lucas Machine Works, Broad and Noble Sts., Philadelphia, Pa.

ERASING FLUID FOR WATERPROOF INK.

The Inkoff Mfg. Co., 314 Madison Ave., New York, manufactures the erasing fluid "Inkoff" from which the firm takes its name. A sample which has been tried in this office appears to give very good results on tracing cloth. It can be used repeatedly on the same surface without injuring the cloth and it dries very quickly. It is said to contain no acids injurious to the hands or tracing cloth. It acts as a solvent, being successful with waterproof inks as well as with ordinary black ink.

IMPROVEMENTS IN AN ELECTRIC HOIST.

The electric hoist manufactured by the Yale & Towne Mfg. Co., 9-15 Murray St., New York, has recently been improved in several particulars. As ordinarily constructed, it is intended to be suspended by a single swiveling hook from any support that will carry a load, such as a beam, a shear pole or I-bolt on a trolley in the same manner that an ordinary chain block is suspended. This enables the hoist to make a dragging lift at an angle of 45 degrees, and so cover a large floor area. The controller, which is a part of the hoist, is simple to manipulate, a turn to the right causing the load to



Newton Steel Foundry Cold Saw.

be raised and a turn to the left to be lowered. When released the hoist stops. If the operator fails to release the controller an automatic stop opens the circuit, and should a fuse blow out the current would be shut off and the load safely held.

One of the improvements, shown in Fig. 2, consists of turntable collector rings which permit the hoist to swivel continu-

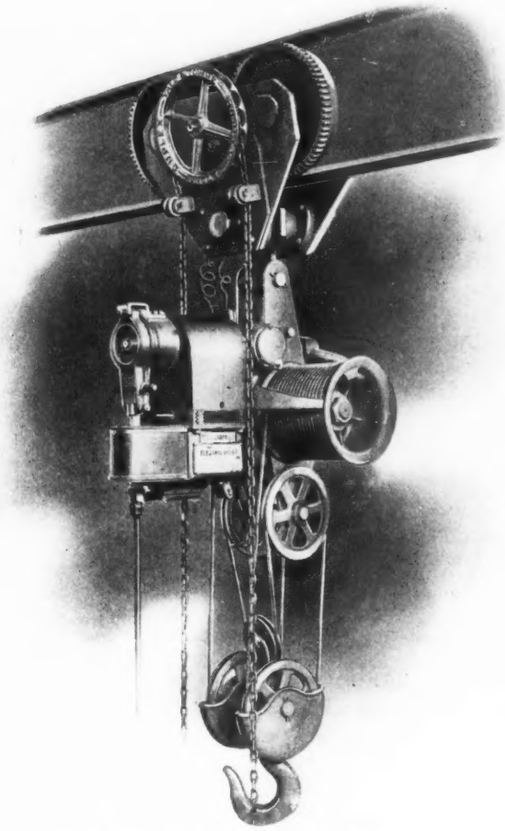


Fig. 1. Yale & Towne Electric Hoist.

ously in one direction without twisting up the leads. The two wires leading to the hoist pass into the top hook and down through its hollow shank to insulated collector rings which are fast to the hook. The hoist is hung from a yoke supported by the hook, which is free to swivel about the shank of the hook and is carried by a ball bearing. Contact between the two collector rings and brushes, as shown in the engraving, conducts the current to motor.

Fig. 2. Collector Rings for Swivel Hook.

In Fig. 1 the hoist has a clevis connection with a geared trolley, which allows the hoist to swing in any direction when raising a load out of line with the center of support, thus enabling it to adjust itself in some degree to an angular lift.

While heretofore these hoists have been constructed for use with wire rope, they are now manufactured with chain lift if desired, and as the chain is not wound on a drum like the rope, the height of the lift with this type is not limited. It is also adapted to the handling of ingots or other heated material where a wire rope hoist might fail, on account of the damaging effect of high temperatures upon such rope.

A Convention Group, not taken for publication.

MACHINE TOOL BUILDERS' CONVENTION.

The spring meeting of the National Machine Tool Builders' Association, which was held at Atlantic City May 1 and 2, was the most largely attended of any meeting that has been held, and the presence of many ladies at the hotel added an attractive feature to the gatherings. The progress of the association was shown by the addition of six new and important firms as members, viz: The Niles-Bement-Pond Co., Cincinnati Machine Tool Co., Cincinnati; W. F. & John Barnes Co., Rockford, Ill.; Rockford Machine Tool Co., Rockford, Ill.; Mechanics' Machine Co., Rockford, Ill., and Dwight Slate Machine Co., Hartford, Conn.

One of the principal events was the meeting of the various committees comprising manufacturers of the different lines of machine tools, to discuss the matter of an increase in price. The planer and shaper sections, as well as the upright drill makers, had already voted an increase of 5 per cent. The lathe manufacturers made a similar advance, this being, of course, in addition to that decided soon after the New York meeting in December, giving a total increase of 10 per cent. No reports were received from the manufacturers of radial drills, milling machines, boring mills and sensitive drills.

Mr. E. P. Bullard, Jr., read a paper on the apprenticeship system in which the relation of this question to the trade was considered in all its bearings. This paper, which is a very suggestive one, we hope to reproduce in the July issue of MACHINERY. Another matter which was discussed, related to the investigation of the subject of obtaining the cost of production of machine tools. Ignorance on this point on the part of many manufacturers has been a disturbing factor to the trade in times past. When a machine tool builder has somewhat hazy ideas on this subject, although he may be running his business profitably as a whole, he is yet almost certain to assign too large a share of the cost of manufacture to one part of his line and too small a share to the remainder. Under these circumstances there will often be some tools which he is prepared to sell in competition with other manufacturers for prices considerably below the minimum cost of manufacture. This action demoralizes business, besides being in the long run inimical to the interests of the firm which makes the mistake. A committee composed of the following members was appointed to investigate this matter of cost accounting: F. A. Geier, E. P. Bullard, Jr., and C. H. Alvord. It is hoped that this committee will be able to recommend a standard method of cost accounting which will put all the builders in the field on the same basis, and eliminate the possibility of any one selling machinery unknowingly at a price below the cost of production. It was voted to hold the next meeting, which will be the annual meeting, in New York City in October. The executive committee will decide later as to the headquarters and date.

* * *

THE FATE OF THE METRIC BILL.

As most of our readers who have been interested in the Littauer metric bill know, this legislation has received its quietus, the House committee having voted not to report it favorably, thus putting an end to the metric agitation for this session at least, and we hope for a number of years. This result was accomplished after a campaign of unusual vigor and persistence, and is a cause for congratulation among machinery manufacturers.

* * *

PERSONAL.

Mr. C. Frank Schwep has been appointed general purchasing agent of the Ingersoll-Rand Co., with headquarters at 11 Broadway, New York. Mr. Schwep has been at the head of the purchasing department of the Ingersoll-Sergeant Drill Co. for the past thirteen years, being located at the shops of Easton, Pa., and Phillipsburg, N. J.

The Baush Machine Tool Co., Springfield, Mass., at the annual meeting held on April 23 made the following changes in the list of officers of the company. Mr. Edward A. Appleton was elected president to succeed Mr. H. R. Dalton, Jr., who resigned. Mr. G. Frank Adams was elected vice-president; Mr. C. J. Wetsel was elected treasurer and general manager, and F. E. Bocorselski was elected superintendent.

Joseph V. Woodworth, a contributor to our columns, and author of several works on modern machine shop practice, has transferred his office to 383 Pearl St., Brooklyn, N. Y., where, as a consulting expert, he is prepared to advise, either personally or through correspondence, along the lines of interchangeable manufacturing, sheet metal working, steel treatment, and the reduction of manufacturing costs.

Eugene N. Foss, known to our readers as the head of the B. F. Sturtevant Co. and the Becker-Brainard Milling Machine Co., is now in Europe. He has gone abroad partly for rest, but particularly to meet some of the leading statesmen and merchants of England and the continent, in connection with his studies of certain economic questions in their relation to the foreign trade of the United States.

* * *

OBITUARY.

Henry C. Williamson, of Michigan City, Ind., died April 29, aged 70 years. He was mechanical superintendent and engineer of the Haskell & Barker Car Works of that place.

George E. Dana died at his home in Syracuse, N. Y., April 18, 1906. He was born in Lowell, Mass., in 1834, and graduated from Harvard College in 1854. For a long period of years he had been connected with the Whitman & Barnes Mfg. Co., Chicago, having been secretary of the corporation, then vice-president, and from 1889 to 1902 president. He was then elected chairman of the board of directors and held that position at the time of his death. Mr. Dana was also a director in two banks in Syracuse, and was financially interested in several other enterprises.

* * *

FRESH FROM THE PRESS.

STRUCTURAL STEEL WORK. Published by Chas. Griffin & Co., London, England, and the J. B. Lippincott Co., Philadelphia, Pa. 248 pages, illustrated. Price $3.50.

This treatise gives an elementary discussion of structural steel work for civil and mechanical engineers and architects who have to design and superintend the erection of steel structures of various kinds; but little attention is given to the mathematics of steel work, the matter being largely descriptive. The book is divided into two parts, the first taking up practical designing, and the second shop work. In the first part there is a discussion of the factors governing the design of structures and specifications, and the inspecting and testing of material and estimating are considered. In the second part, the equipment and method of producing work economically in the different departments of a structural steel shop is taken up, the various chapter headings being "The Template Shop," "The Girder Shop," "The Smith Shop," "General Equipment," besides chapters treating of miscellaneous matters.

HEAT AND LIGHT FROM MUNICIPAL AND OTHER WASTE. By Jos. G. Branch. 305 pages 5½ x 7¾ inches and 56 cuts. Published by Wm. H. O'Brien Printing and Publishing Co., St. Louis, Mo. Price $3.00.

This book is written for municipalities, and engineers concerned with the economic disposal of waste material. The importance of disposal of municipal waste in a way that shall not be offensive to the

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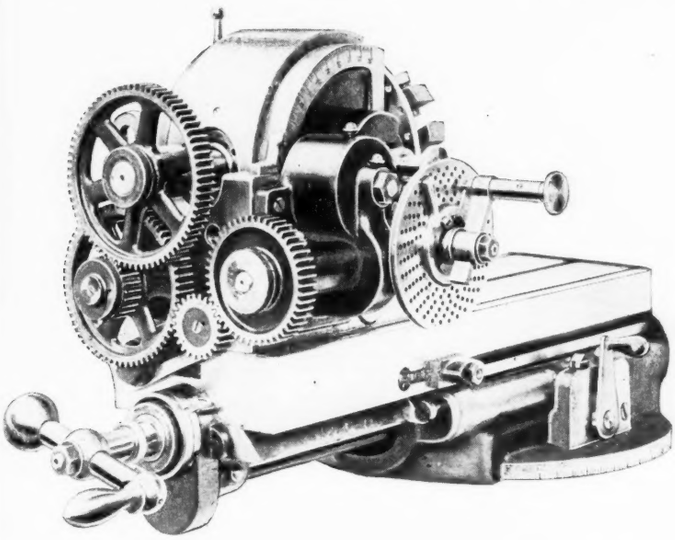

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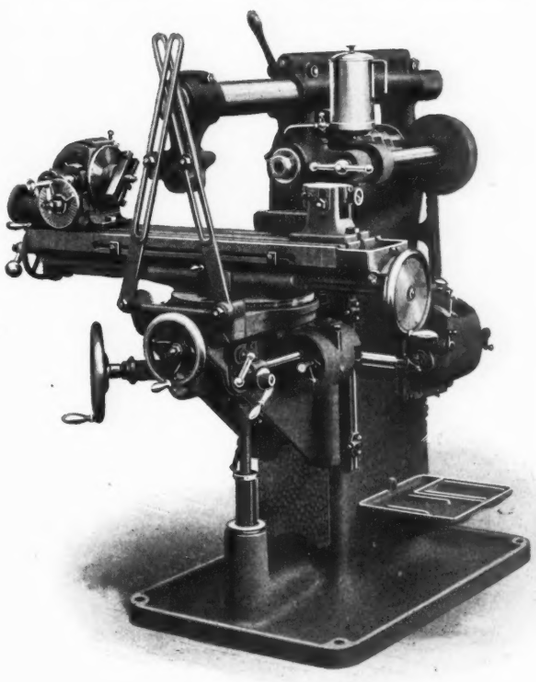

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general public and at the same time reduce the expense of such a disposal to a minimum is generally recognized, but very little has been done in that direction in the United States. To show how far behind American cities are in this respect we quote from the author's opening remarks. He states that the cost of refuse disposal rarely exceeds 1 cent per capita in any foreign city while it cost Philadelphia 38 cents per capita in 1903; Chicago 37 cents; St. Louis 44 cents; Boston $1.09, and New York 2 cents. In fourteen cities having a population above 300,000 the cost of waste disposal averaged 28 cents per capita. The book treats of municipal and other waste incineration and reduction, foreign distributors and incinerators, the use of waste for generating electricity, etc.

ELECTRIC POWER TRANSMISSION. By Louis Bell. 721 pages, 6 x 9 inches; 341 cuts. Published by the McGraw Publishing Co., New York. Price $4.00.

This book was first pubished in 1897, and the copy in review is of the fourth edition. Although there have been no startling innovations in electric power transmission since the book was first published there has been a marked engineering development, and considerable matter contained in the first edition has been eliminated as obsolete. The increase in high-voltage plants has made it virtually impossible to keep track of the 10,000 volt power transmission plants, hence the list of high-voltage transmission plants contains nothing under 20,000 volts. This list includes 103 American installations, ranging from 60,000 down to 20,000 volts. Following are the titles of the chapters: Elementary Principles; General Conditions of Power Transmission; Power Transmission by Continuous Currents; Some Properties of Alternating Circuits; Power Transmission by Alternating Currents; Alternating Current Motors; Current Reorganizers; Engines and Boilers; Water-Wheels, Hydraulic Development; The Organization of a Power Station; Auxiliary and Switchboard Apparatus; The Line; Line Construction; Methods of Distribution; The Commercial Problem; The Measurement of Electrical Energy; High Voltage Transmission. In view of the growing importance of long-distance power transmission in developing remote water powers, the work is one that should be much appreciated; it is written plainly and should come within the comprehension of any engineer, even if not "up" in electrical matters. For this reason it should be a valuable guide in the preliminary survey of water powers, the development of which would require the services of experts but whose preliminary work or prospecting might be initiated by a "business engineer."

"COMPRESSED AIR" appeared with its May issue in enlarged form and under new management. It is now published by the Kobbe Co., 90-92 West Broadway, New York. A special feature of the paper is the department devoted to correspondence and that of "Practical Items for Practical Men," which latter contains data of direct and practical value to users of compressed air. W. L. Saunders remains editor-in-chief, W. R. Hulbert is managing editor and P. F. Kobbe, business manager. This paper is devoted exclusively to the field of compressed air in all its applications.

NEW TRADE LITERATURE.

NILES-BEMENT-POND CO., 111 Broadway, New York. Catalogue of Outdoor Cranes illustrating with excellent engravings the operation of a number of electric Niles cranes.

PERRY TIME STAMP CO., Chicago, Ill. Booklet entitled "The Business Man's Time Saver." This tells of the different uses of the stamp and describes the mechanism of same.

THE RIVETT-DOCK CO., Brighton, Mass. Catalogue describing the Rivett-Dock thread tool. Illustrations of the tool in operation and of work done by the tool are shown.

E. F. REECE CO., Greenfield, Mass. Catalogue No. 6, describing and giving price lists of their line of dies, die holders, hand machine and tapper taps, etc. The "Hercules" hand and power bolt cutters and nut tappers are also described. A number of useful tables are given.

THE OWEN MACHINE TOOL CO., Springfield, O. 1906 Catalogue of Milling Machines. Their various types of positive feed, universal, duplex and hand milling machines are illustrated and described, and descriptions of a number of attachments are given.

NATIONAL MACHINERY CO., Tiffin, O. Bulletin No. 20, dealing with National multiple spindle bolt cutters. A number of the cutters are illustrated, general specifications and detailed description of the head are given.

B. F. STURTEVANT CO., Hyde Park, Mass. Bulletin No. 131, describing horizontal engines class HCl. Illustrations of a number of parts of the engine are given and tables of dimensions and net horse powers are included.

THE SCHELLENBACH & DARLING TOOL CO., Cincinnati, O. Catalogue of reamers and special tools. The book opens with suggestions for the use and care of reamers, and goes on to describe their various types of reamers. In the back of the book are reproduced a number of letters endorsing the reliability of their product.

INGERSOLL-RAND CO., 11 Broadway, New York City. Catalogue R 10 A of Imperial Type X Air Compressors. A general description of this compressor takes up briefly all of its various parts, following upon which various types are illustrated and specifications for each given.

LUCAS MACHINE TOOL CO., Cleveland, O. Pamphlet entitled "Rathskeller and Roof Garden," pointing out a few advantages of the "Precision" boring, drilling and milling machine, which may be located on any floor of a building. It has a stiff box bed, is self-contained and requires no foundation.

THE VITRIFIED WHEEL CO., Westfield, Mass. Catalogue of Emery and Corundum Wheels, showing diagrams of shapes of faces for wheels most commonly used for wood working tools, and diagrams and dimensions for special shaped wheels. Price lists for emery and corundum wheels, cup wheels, etc., are also included. In the back specifications and illustrations of their grinding machinery are given.

THE CINCINNATI LATHE & TOOL CO., Cincinnati, O. Pamphlet illustrating and describing the Cincinnati sixteen-inch quick change gear engine lathe. The lathe was designed to withstand the heavy duty required of modern machine tools, and to meet the demand for machines capable of increasing the output with accuracy, simplicity and rapidity.

THE SPRAGUE ELECTRIC CO., 527-531 W. 34th St., New York City, as a fore-warning of the hot weather to come, have issued Catalogue No. 312 on Electric Fans. In addition to their regular line of standard direct current motors, they are now listing high class alternating current electric fans, desk and bracket type. These types are illustrated and code words, descriptions and prices are given.

J. J. MCCABE, 14 Dey Street, New York. Catalogue of McCabe's double spindle lathe, illustrated. This well-known lathe is designed to combine the utility of a 48-inch and a 26-inch lathe and is built with any desired length of bed and equipped with motor drive if so ordered. Several illustrations are shown to indicate the variety of work the lathe is adapted for.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Especially appropriate at this season of the year is the pamphlet on Spring Painting which has recently been issued. It urges that at this "annual renewal season of nature, it would be in keeping to renew the faded and broken coatings on metal and woodwork." Ticonderoga Flake Graphite is recommended for this purpose.

THE CRESCENT MACHINE CO., Leetonia, O. Catalogue of woodworking machinery describing band saw machines, band saw blades, saw tables, jointers and their two new machines—the Crescent angle band saw and the Crescent panel band saw. Various types of band saws are illustrated, dimensions and equipment for each being given. Price list is also included.

THE BROWNING ENGINEERING CO., Cleveland, O. Bulletin No. 24, "in the interest of the lumber industry." This illustrates with a number of excellent engravings the "Browning" logging machinery in operation. The machinery consists of a complete line of steam-driven, self-propelled machines designed and equipped for the economical and rapid handling of logs, etc.

THE CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 64 describing Form I motors and generators. This machine is particularly well adapted for driving machinery, especially machine tools. Modifications have recently been made in the frame, which now has the advantages of an open type motor, although it may be fully enclosed when desired.

E. J. BOWERS, 3029 Chestnut Street, Philadelphia, Pa. Pamphlet describing multiple stop attachment for lathes. This device may be used on the engine lathe for either the carriage or cross slide motions, or both, and provides means with a single tool in the holder for turning a number of diameters and shoulders on a single piece of work, thus fulfilling the function of a turret lathe. Full directions are given for ordering the device.

STAR CORUNDUM WHEEL CO., LTD., Detroit, Mich. Illustrated catalogue No. 8 of Emery and Corundum Wheels, Grinding Machinery and Sharpening Devices. It has been especially aimed to make this catalogue one of the most complete issued, and the result is of value to those interested in this line of work. The different types are described, prices listed and convenient rules, such as for calculating speeds and diameters of pulleys, are given.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, O. Bulletins Nos. 101 of Dinkey Ventilated Controllers and 102 of Type-U Controllers. These are the first of a series of bulletins which this company is preparing and are arranged in a neat and most convenient form, being made up of separate leaves secured by staples. The bulletins are illustrated and give complete information concerning these controllers.

GISHOLT MACHINE CO., Madison, Wis. Leaflet showing "something new in motor drives." The first illustration shows a Gisholt standard 60-inch horizontal boring and drilling machine direct connected to a 5 H. P. d. c. motor, speed range 400 to 1,600 R. P. M. The motor is mounted directly on the extended base, the armature shaft extend-